Annual Report No. 22 June 30, 1899

THE NORTH CAROLINA

College of Agriculture and Mechanic Arts

AGRICULTURAL EXPERIMENT STATION

ALEX. Q. HOLLADAY, LL.D., President
W. A. WITHERS, A.M., Acting Director

Report of the Director

For the Year Ending June 30, 1899

W. A. WITHERS

RALEIGH, N. C.

518

Publications will be sent to any address in North Carolina upon application

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION.

MARCH 12, 1877:
Chartered by the General Assembly of North Carolina as a department of the State Agricultural Department.

APRIL 19, 1877:
Organized at University of North Carolina.

AUGUST, 1881:
Removed to State Agricultural Department Building, at Raleigh.

MARCH 2, 1887:
Passage of Hatch Act by the U. S. Congress.

DECEMBER 8, 1889:
Became a department of the N. C. College of Agriculture and Mechanic Arts by authority of the Act of the General Assembly of March 7, 1887.

JULY 14, 1897:
Removed to the College Grounds.

COMMISSIONERS OF AGRICULTURE

Exercising general control of the Experiment Station from 1877 to Dec. 8, 1889.

April 2, 1877, to May 24, 1880:
L. L. POLK.

May 25, 1880, to October 19, 1880:
P. M. WILSON (Acting).

October 19, 1880, to April 22, 1887:
MONTFORD McGEHEE.

April 22, 1887, to December 8, 1889:
JOHN ROBINSON.

PRESIDENT OF THE COLLEGE

Exercising general control of the Experiment Station since Dec. 8, 1889:
ALEX. Q. HOLLADAY.

DIRECTORS OF THE EXPERIMENT STATION

April 19, 1877, to October 31, 1880:
ALBERT R. LEDOUX,
Columbia College; Univ. of Berlin; A. M., Ph. D., Univ. of Gottingen.

November 1, 1880, to August 31, 1887:
CHARLES W. DABNEY, JR.,
Hampden-Sidney College; Univ. of Va.; A. M., Ph. D., Gottingen.

September 1, 1887, to June 30, 1897:
H. B. BATTLE,
B. S., Ph. D., Univ. of North Carolina.

Since July 1, 1897 (Acting):
W. A. WITHERS,
A. B., A. M., Davidson College; (Fellow) Cornell University.

RALEIGH, N. C., June 30, 1899.

To His Excellency, HON. DANIEL L. RUSSELL,

Governor of North Carolina.

DEAR SIR:—In response to your request, I have the honor to submit herewith the twenty-second report of the operations of the Agricultural Experiment and Fertilizer Control Station of the North Carolina College of Agriculture and Mechanic Arts.

I am, very respectfully, your obedient servant,

W. S. PRIMROSE,

President Board of Trustees.

THE NORTH CAROLINA
COLLEGE OF AGRICULTURE AND MECHANIC ARTS,
PRESIDENT'S OFFICE.

RALEIGH, N. C., June 30, 1899.

HON. W. S. PRIMROSE,
President Board of Trustees.

SIR:—I transmit herewith the report of Professor W. A. Withers, Acting Director of the North Carolina Experiment Station, from July 1, 1898, to June 30, 1899, inclusive. It furnishes a full and clear statement of the work of the Station, together with many gratifying evidences of steady growth and increased usefulness to the State under its present head. I have the honor to be

Very respectfully,

ALEX. Q. HOLLODAY,
President.

THE N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.
AGRICULTURAL EXPERIMENT STATION,
OFFICE OF THE DIRECTOR.

RALEIGH, N. C., June 30, 1899.

To ALEX. Q. HOLLADAY, LL.D., *President.*

SIR:—I have the honor to submit herewith a report of the operations of the North Carolina Agricultural Experiment Station, for the year ending June 30, 1899, in accordance with Section 3, of the Hatch Act, of the Congress of the United States, for the maintenance of Agricultural Experiment Stations in the various States and Territories.

I trust the report will prove satisfactory to yourself, the Board of Trustees and his Excellency, the Governor of the State, to whom I should be pleased for you to transmit it in accordance with the law above referred to.

Very respectfully,

W. A. WITHERS,
Acting Director.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

Alex. Q. Holladay, LL.D., President of the College.*
W. A. Withers, A.M., Acting Director and Chemist.*
F. E Emery. M.S., Agriculturist.*
W. F. Massey, C.E., Horticulturist.*
Cooper Curtice, D.V.S., M.D., (1) Veterinarian.*
G. S. Fraps, Ph.D., Assistant Chemist.
J. A. Bizzell, B.S., Assistant Chemist.
H. W. Primrose, B.S., Assistant Chemist.
Alex. Rhodes, Assistant Horticulturist.
C. W. Hyams, Assistant Botanist.
J. M. Johnson, M.S., Assistant Agriculturist.
B. S. Skinner, Farm Superintendent.
J. M. Fix, Secretary.
C. M. Hughes, B.S., Clerk.
Mrs. L. V. Darby, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. Blair, A.M., State Chemist.
C. B. Williams, M.S., Assistant Chemist.
C. D. Harris, B.S., Assistant Chemist.
F. G. Kelly, Assistant Chemist.
W. G. Haywood, B.Litt., Assistant Chemist.
H. E. King, Chief Clerk.
Miss M. S. Birdsong, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

*Member of Station Council.
(1) On leave of absence.

TABLE OF CONTENTS.

REPORT OF THE DIRECTOR

OF THE

AGRICULTURAL EXPERIMENT STATION,

FOR THE YEAR ENDING JUNE 30, 1899.

North Carolina has the distinguished honor of being the second of the United States to establish an Agricultural Experiment Station, and it should be our ambition to maintain the grade of work contemplated by those who induced the people of the State to take the advanced step.

RELATION OF THE STATION TO THE NORTH CAROLINA DEPARTMENT OF AGRICULTURE.

By an Act of the General Assembly of March 12, 1877, the North Carolina Department of Agriculture was established and the Agricultural Experiment and Fertilizer Control Station was also established under the management of its Board of Control. Five of the Board were members *ex-officio*, viz.: The Governor of the State (Hon. Z. B. Vance), the State Geologist (Prof. W. C. Kerr), the Master of the State Grange Patrons of Husbandry (Capt. S. B. Alexander), the President of the State Agricultural Society (Hon. Thos. M. Holt), and the President of the Agricultural College (Dr. K. P. Battle). Two members were appointed from the State at large, viz.: Capt. Jas. R. Thigpen, of Edgecombe, and Major Jonathan Evans, of Cumberland. On the 21st day of the month in which the Act was ratified this Board organized, and among other things elected as Chemist and Director of the Experiment Station, Dr. Albert R. Ledoux, of New York. The Director was commissioned on April 18, 1877, and entered upon his duties the following day. With a beginning under the management of a Board composed of such distinguished citizens, it is not surprising that the Station has grown to its present state of usefulness and to its warm place in the affections of the people.

When the Department of Agriculture was organized, it occupied rented apartments. While much valuable work was done under these conditions, it was soon found that more spacious quarters were needed, and the present Agricultural Department Building located just north of the Capitol, was purchased. For purposes of convenience, the Station, which had previously been located at Chapel Hill in the apartments so kindly furnished by the State University,

was removed to this building in Raleigh in August, 1881, in accordance with the Act of the General Assembly of that year.

On March 2, 1887, the Act of Congress, which is popularly known as the Hatch Act, was approved, and in accordance with the general plans for Experiment Stations outlined in that Act, the General Assembly of North Carolina, on March 7, 1887, ratified an Act authorizing the Board of Agriculture to transfer the Station to the North Carolina College of Agriculture and Mechanic Arts. The College was not opened for the admission of students until the fall of 1889. On December 8, 1889, at the first meeting of the Board after the opening of the College, the Station was formally transferred to and made a department of the College. Since the date of the transfer the Station has had no official connection with the Department of Agriculture except that, in accordance with special contracts, entered into from time to time, it has been making the analyses for the Fertilizer Control.

But although the Experiment Station has at present no official connection with the State Department of Agriculture, yet on account of its connection for ten years, and for the friendly interest which has since been manifested on many occasions by the Department of Agriculture, the management of the Station will always feel the warmest interest in the Department and in the success of the great work which it was organized to accomplish for the farmers of the State.

RELATION OF THE STATION TO THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

Although the Station was organized under the control of the Board of Agriculture, yet its work for four years was performed at Chapel Hill, in connection with the University of North Carolina, which at that time was the State Agricultural College, and enjoyed the benefits of the land scrip fund. Director Dabney, in the biennial report for 1879 and 1880, speaks of the value of this association in the following language: "Our location at the University affords us further opportunities of frequent easy conference with members of the faculty, who, as skilled specialists in their several departments of science, have, on many occasions, assisted us in word and deed in the prosecution of investigations."

On December 8, 1889, the Station was formally transferred to the North Carolina College of Agriculture and Mechanic Arts by the Board of Agriculture and accepted by the Board of Trustees of the College, in accordance with the Act of the General Assembly of March 7, 1887. In connection with this transfer, Director Battle said, in his report for 1889: "In becoming a department of the College, both the Station and College will be mutually able to receive and to give aid in the conduct of the work, both of instruction and experi-

mentation. It is believed that by this arrangement both the Station and College will accomplish more complete and thorough work."

At the present time College duties are performed by all the scientific members of the Station staff, excepting those who are connected with the Fertilizer Control Division. We most cordially confirm the opinions of Directors Dabney and Battle as to the value of the association with the College, and take this occasion to express to our colleagues in the faculty, and to the members of the student body, our appreciation of the stimulating influence which has come from daily contact with them.

RELATION OF THE STATION TO THE FERTILIZER CONTROL.

Since the separation of the Experiment Station from the Department of Agriculture and its connection with the Agricultural College, it has pleased the two Boards for the Experiment Station to continue making the Fertilizer Control analyses for the Department of Agriculture. This work is performed by contract for a specified sum. The present contract expires June 30, 1899. At that time the Fertilizer Control work, in accordance with the Act of the General Assembly of 1899 passes from the Experiment Station to the direct control of the Board of Agriculture. The analytical work for the Fertilizer Control has been performed entirely in the laboratories in the Agricultural Department building in Raleigh just north of the Capitol. This work has constituted an independent division of the Station.

RELATION OF THE STATION TO THE STATE GOVERNMENT.

The expense of maintaining the Station work, (with the exception of the Fertilizer Control Division), is borne entirely from the funds appropriated by the United States Government, in accordance with what is popularly known as the Hatch Act, and no appropriation is made for this work by the State of North Carolina, or by any department of the State Government.

The Station is under the control of the Board of Trustees of the North Carolina College of Agriculture and Mechanic Arts. That Board is appointed by the State authorities, and uses its discretion in the management of the affairs entrusted to it, just as any other Board appointed by State authority does, except that, in accepting the gift of Congress, the State pledged itself to expend the amounts donated in accordance with the purposes expressed in the Act making the gift.

It is a matter of some regret that the State, which was the second in the United States to establish and maintain an Agricultural Experiment Station, and which took this advanced step ten years before the passage of the Hatch Act, should withdraw all support, and leave

it to be maintained solely by the Federal Government just as soon as the Federal Government extended a helping hand. As science progresses, and as the demands of agriculture become greater, it will be necessary for the Station to enlarge its scope of work or fall behind its sisters. The Station needs more buildings, enlarged equipment and additions to its staff, and these can not be obtained without increased revenue or the curtailing of work already begun.

It is hoped that in the near future the State will assist in the work at least to the extent of printing the bulletins, etc.

RELATION OF THE STATION TO THE FEDERAL GOVERNMENT.

The North Carolina Station was established ten years before the passage of the Act of Congress, popularly known as the Hatch Act, which provided for the establishment and maintenance of an Agricultural Experiment Station in each State and Territory of the Union. Since the passage of the Act the Station work has been maintained solely by the funds received from the United States Government. Although the Station is under the control of a Board of Trustees appointed by State authorities, yet the Federal Government exercises a supervision over its work and expenditures, and causes an inspection to be made each year by an official representative.

A report referring to the work of each Station is transmitted to Congress each year by the Secretary of Agriculture. The Secretary is endeavoring to bring these Stations into closer touch with one another and with the United States Department of Agriculture, and to make the work of each conform more nearly to the purposes expressed in the Act of Congress of March 2, 1887. The Secretary has found it necessary to make rulings against maintaining substations, ordinary or even model farms, information bureaus and chairs of instruction out of the appropriations made by the Act of Congress referred to, a copy of which is inserted here.

THE HATCH ACT.

ESTABLISHING AGRICULTURAL EXPERIMENT STATIONS.

AN ACT to establish Agricultural Experiment Stations in connection with the colleges established in the several States under the provisions of an Act approved July second, eighteen hundred and sixty-two, and of the Acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an Act approved July second, eighteen hundred and sixty-two, entitled "An Act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and

the mechanic arts,"or any of the supplements to said Act, a department to be known and designated as an "Agricultural Experiment Station": *Provided*, That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the Legislature of such State or Territory shall otherwise direct.

SEC. 2. That it shall be the object and duty of such Experiment Stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said Stations, it shall be the duty of the United States Commissioner of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this Act. It shall be the duty of each of said Stations annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said Stations, to the said Commissioner of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said Stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far as the means of the Station will permit. Such bulletins or reports and the annual reports of said Stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July, and October under the provisions of section eight of this Act, out of any money in the in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however*, That out of the first annual appropriation so received by any Station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such Station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said Stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual

appropriation to such Station, in order that the amount of money appropriated to any Station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this Act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this Act and having also Agricultural Experiment Stations established by law separate from said Colleges, such States shall be authorized to apply such benefits to experiments at Stations so established by such States; and in case any State shall have established under the provisions of said Act of July second, aforesaid, an agricultural department or Experimental Station, in connection with any university, college, or institution not distinctively an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or Station, the Legislature of such State may apply in whole or in part the appropriation by this Act made to such separate agricultural college or school, and no Legislature shall by contract, express or implied, disable itself from so doing.

SEC. 9. That the grants of moneys authorized by this Act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its Legislature meeting next after the passage of this Act shall be made upon the assent of the Governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this Act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this Act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

DEVELOPMENT OF EXPERIMENT STATION WORK.

The first work undertaken by the Experiment Station for the farmer was the analysis of fertilizers. Without the aid of the chemist the farmer was unable to protect himself against the frauds practiced by unscrupulous fertilizer manufacturers. The value of this work inspired the farmer with confidence in scientific work and taught him that there were important problems which he could not solve for himself in the field, and for whose solution he must rely upon the laboratory worker.

The farmer very naturally concluded that the man who could give him help in regard to his fertilizers could give him help in regard to other matters on the farm, and in consequence he plied the Station with questions. Much of the information desired could be obtained from the agricultural literature already in existence, and it was always cheerfully furnished by the members of the staff.

Frequently the farmer asked for information which the scientific man did not possess, and which he must obtain from nature first hand, if at all. By the joint efforts of "the man with the hoe," the man with the balance and the man with the miscroscope, much valuable information has been obtained and agricultural literature has been greatly enriched.

These three stages are fairly represented in the work of the Experiment Station as a police bureau, as an information bureau, and as a bureau for agricultural investigation.

SCOPE OF STATION WORK.

The police work is probably not performed now by a single Station in the United States at the expense of the Hatch fund. In many States however, this police work is performed by the Stations, but is maintained out of funds derived entirely from other sources. This police work has related to fertilizer and food analyses, nursery inspection, etc. Its importance to the farmers has been very great, and its value in popularizing the Stations can not be overestimated. It does not now hold the chief place in Experiment Station work however.

It is a popular idea that the farmer looks with some suspicion upon agricultural literature. When, however, we turn to our own mailing list we find that there is a great demand for our own bulletins. We find that the excellent "farmers' bulletins" of the United States Department of Agriculture are published in large quantities, and are eagerly sought for. We find there is a constant addition of new agricultural books to the shelves of the bookseller. From these facts we are forced to conclude that the farmer is not so suspicious of agricultural literature as some would have us suppose.

Surely no one would underestimate the value of good agricultural literature, and yet it is questionable what portion of the Hatch fund should be used by any Station for diffusing information not obtained first hand by members of its own staff as a result of their own investigations. The only authority for such use at all is in section one of the Act, and that by a construction which is questionable if viewed in the light of subsequent sections. That is a matter however, which will adjust itself in due time. It is certainly not the main object of the Station work to publish information bulletins, for if so, the word "experiment" would not be in the name and "investigations" would not be referred to so frequently in the Act, and there would be no need for experimental fields, stables, dairies, or laboratories, but only for the tripod, shears, paste brush, and printing office. On the other hand, however, it is probably true that in each State there are plants, methods of culture, of harvesting, etc., with which the farmer is not familiar, and until he is he will probably not be greatly interested in any investigations which made be made in that connection. It has been the custom of this Station from time to time to issue information bulletins when we felt that our farmers would profit by them. As a rule we have found them eagerly read and fully appreciated. When the field is fully covered by the bookmakers and by the National and State Departments of Agriculture it

is probable that it will be cheerfully abandoned by the Experiment Stations.

The main purposes, however, for which the Experiment Stations were established are "to conduct original researches or verify experiments * * * bearing directly on the agricultural industry * * *."

To search for the unknown is difficult. Sometimes the information sought for is never found, and when found it is frequently after a long and tedious search.

It is not surprising that this purpose is not as yet fully appreciated by the farmers of the United States. It is probably well for even governing boards and members of the Station staff to keep the language of the Hatch Act constantly before them.

THE IDEAL EXPERIMENT STATION.

The success of the few Experiment Stations which were in existence before 1887 made it desirable to enlarge the field of work. Too much can not be said in praise of the efforts of the Hon. W. H. Hatch, of Missouri, and his colleagues who secured the passage by Congress of the Act which makes an appropriation for each Experiment Station in the United States. The words of the Act outline well the work.

The aim of the Experiment Station has been interpreted by many, but it would be difficult to find a better interpretation than that given by Secretary Wilson in his report of the Department of Agriculture for 1898, in which he says: "College duties should not be allowed to encroach on the time set apart for original investigation, and the compilation of old information should always be made secondary to the acquirement of new knowledge. * * The Stations are not the only means for the education of the farmer; agricultural colleges, farmers' institutes, boards of agriculture, and various other agencies have been established to instruct the farmer regarding the present status of agricultural science as applied to his art. It is the business of the Experiment Station, on the other hand, to advance knowledge of facts and principles underlying successful agriculture, and to teach the farmer new truths made known by their investigations. The Act of Congress creating the Stations clearly defines their functions to be the making and publishing of original investigations. Wherever a Station has neglected this, and merely endeavored to educate the farmer, we find a weak Station, and wherever the Station has earnestly devoted itself to original investigations, we find a strong Station. The Station may very properly lend its influence to strengthening the influence and work of the educational agencies established for the farmer's benefit, but it fails to fulfill its real mission when it resolves itself into a bureau of information, or devotes

a large share of its energies to the compilation of popular treatises on agriculture. It is gratifying to observe that the original investigations at our Stations are increasing in number and improving in quality."

If the writer did not speak with the authority of the high office he holds, his words would still be of the greatest weight, when consideration is given to his successful experience as a practical farmer, a Professor of Agriculture, an Experiment Station Director and Member of Congress.

Doubtless there are few Stations which do not endorse the views of the Secretary and strive for the ideal pictured by him.

GROWTH OF THE NORTH CAROLINA STATION.

The work of the Experiment Station began on April 19, 1877, under the Directorship of Dr. Albert R. Ledoux, of New York. Dr. Ledoux was graduated with the degrees of A. M. and Ph. D., from the University of Gœttingen. He had also been a student at the School of Mines, Columbia College, New York, and at the University of Berlin. In his report for 1879, Director Ledoux writes of the equipment he had in beginning his work: "I was given a table in the quantitative analysis room among the students, and gas, water, balances, reagents, bottles and some apparatus were placed at my disposal." The Station work was begun, therefore, with one man, with one table and a part of one room at his disposal. The University very soon assigned more ample apartments to the Station and the State Department of Agriculture provided equipment. It soon became necessary for the Director to have assistants in order to answer the many calls made upon his energies, and the Board of Agriculture provided these assistants.

The Station began its work in a chemical laboratory, and although cooperative field experiments were conducted, and although some work was done in the way of seed testing, yet the main work of the Experiment Station for several years was in the chemical laboratory. The Station turned its attention at first most wisely to the Fertilizer Control, following the lead of the Connecticut Station, as well as of the first Station established in Germany. It is impossible to estimate the amount saved to the farmers by preventing fraud in their fertilizers.

On November 1, 1880, Dr. Chas. W. Dabney, Jr., of Virginia, succeeded to the Directorship. He was graduated with the degrees of A. M. and Ph. D. from the University of Gœttingen, and had previously been a student at Hampden-Sidney College, and the University of Virginia.

While the Station work in the laboratory was well done, and commended itself most favorably to the people of the State, it was felt that far more effective work could be accomplished for the farmers of

2

the State by the establishment of an experimental farm, so that the field and laboratory workers could be in closer contact. For experimental purposes a few acres of land were purchased on the Hillsboro road just west of the Fair Grounds. In April, 1886, Professor Milton Whitney, of the Connecticut Experiment Station, and a former student at the Johns Hopkins University, entered upon his duties as Agriculturist, and thus the Agricultural Division was established. Professor Whitney was succeeded by Professor J. R. Chamberlain, of New York, a graduate of Cornell University, and he in turn by Professor Frank E. Emery, of Maine, the present incumbent, who served for awhile as a member of the staff of the Houghton Farm and of the New York Experiment Station at Geneva, and who had previously been graduated at the University of Maine.

In December, 1886, the State Weather Service, operated in conjunction with the United States Signal Service, was established in connection with the Experiment Station. This connection was severed on October 1, 1896, when the North Carolina Section of the Climate and Crop Service, which succeeded to the duties of the Division, was established under the direct management of the United States Weather Bureau. The Meteorologists of the Station have been W. O. Bailey, H. McP. Baldwin and C. F. von Herrmann, all of the United States Signal Corps.

On September 1, 1887, Dr. H. B. Battle, of North Carolina, and a graduate of the State University, with the degrees of B. S. and Ph. D., succeded to the Directorship. Dr. Battle had previously served for more than six years as Assistant Chemist in the Experiment Station.

On October 1, 1888, the Botanical Division of the Station was established by the appointment of Professor Gerald McCarthy as Botanist. Professor McCarthy performed temporarily, at first, the Entomological work of the Station, and at a later date this work was assigned to him formally.

On December 8, 1889, the horticultural work was begun by the appointment as Horticulturist of Professor W. F. Massey, who had been elected to fill the corresponding chair in the recently opened College of Agriculture and Mechanic Arts. Professor Massey had been a student at Dickinson College, Pennsylvania, and Union College, New York, from which latter institution he was graduated with the degree of C. E. For a number of years he had been connected with the Miller Manual Training School of Virginia. On September 1, 1897, the work in Horticulture, Botany and Entomology was consolidated.

On July 1, 1897, the writer, who had served the College since its foundation as Professor of Chemistry, and who had been previously an Assistant Chemist in the Experiment Station for five years, was made Chemist to the Station. He was asked to perform temporarily the duties of the Directorship.

In the older Experiment Stations of Germany, as at Mœckern, Halle and Gœttingen, it has been found best, on account of the increase in the scope of Station work, to place the analytical work of the Fertilizer Control in a division separate and apart from the experimental chemical work of the Station. The same plan has been followed in other Experiment Stations in the United States which have the Fertilizer Control work. In some States the Fertilizer Control work has no connection with the Experiment Station, but is managed entirely by the Board of Agriculture. In North Carolina we have found it necessary to make some provision for the increased work, and it has been done by the establishment of a Fertilizer Control Division, which is charged especially with the analytical work for the Fertilizer Control, and with such gratuitous work for the people of the State as the chemists of that Division are able to perform without detriment to their other work. The Fertilizer Control Division came into existence on September 1, 1898. Professor A. W. Blair, who had served the Station for a little more than a year as Assistant Chemist, was made State Chemist. He was graduated with the degree of A. M. from Haverford College,Pennsylvania, and had formerly been a student and Professor of Chemistry in Guilford College, North Carolina.

The Experiment Station at previous times endeavored to meet, to some extent, the calls made upon it by securing, either temporarily or in an advisory capacity, the services of a Veterinarian. It was not possible, however, to secure permanently such services until the appointment of Dr. Cooper Curtice as Veterinarian on October 15, 1898. Dr. Curtice had been connected with the Bureau of Animal Industry of the United States Department of Agriculture. He was graduated at Cornell University with the degree of B. S., at the Columbia Veterinary College with the degree of D. V. S., and at the Columbian University with the degree of M. D.

ORGANIZATION OF THE NORTH CAROLINA STATION.

The Station is a department of the College, and as such, its affairs are under the general control of the President.

The executive officer of the Station is the Director, who is responsible to the President as are the heads of other departments of the College.

The Divisions of the Station beside the Executive, are the Chemical, Agricultural, Horticultural, Botanical, Entomological, Veterinary and Fertilizer Control Divisions.

The Station Council is composed of the President, Director and chiefs of the different Divisions of the Station.

With the exception of the farm and the Fertilizer Control laboratory, the Station is located upon the grounds of the North Carolina College of Agriculture and Mechanic Arts.

CHANGES DURING THE YEAR.

On July 31st Mr. F. E. Hege, Poultryman, severed his connection with the Station.

On September 1, 1898, the Chemist of the Station was relieved of the charge of the Fertilizer Control Division and Mr. A. W. Blair, Assistant Chemist, was made State Chemist, and took charge of the latter Division.

On September 30, 1898, Mr. G. S. Fraps, who was employed temporarily, severed his connection with the Station.

On October 16, 1898, Dr. Cooper Curtice entered upon his duties as Veterinarian. He was given leave of absence from March 15, 1899, to perform duties for the Board of Agriculture, and has not since been in the service of the Station.

On November 1st Mr. A. Rhodes, Assistant Horticulturist, was transferred to Raleigh from Southern Pines, the work at that point having been abandoned.

On November 1, 1898, Mr. W. G. Haywood became Assistant Chemist in the Fertilizer Control Division.

On December 31, 1898, Mr. H. K. Miller, Assistant Chemist resigned and Mr. G. S. Fraps was elected his successor. Mr. Fraps was given leave of absence from January 1st to May 15, 1899 to continue his studies at the Johns Hopkins University. During his absence his duties were performed by Dr. J. M. Pickel.

On January 1, 1899, Mr. H. W. Primrose became Assistant Chemist.

In December, 1898, the chemical work of the Station was transferred to the main building of the College.

Various other changes have been decided upon by the Board of Trustees, but as these do not take place until after the end of the present fiscal year, mention of them is omitted in this report.

PUBLICATIONS OF THE STATION.

The publications of the Station are as follows:

Annual Reports of the Station.—Each edition 1,500 copies. Numbered consecutively with the years, 1-(1878), 2-(1879), 3-(1880), and so on. Prior to 1888 these reports contained results from the year's work, and took the place of separate Bulletins which appeared thereafter. The Annual Reports now contain copies of the regular Bulletins issued during the year, and are sent to exchanges only, and not to the general mailing list. Latest issued is 22nd annual for the year ending June 30, 1899.

Biennial Report of the Station.—Sent to the Governor for transmission to the General Assembly. Each edition 500 to 3,000 copies, numbered consecutively, 1-(1877, 1878), 2-(1879, 1880), 3-(1881, 1882), etc. These reports are demanded by State author-

ities, and are not intended for general distribution. Latest issue was Eleventh Biennial Report for the years 1897 and 1898.

BULLETINS.—*Regular.* Each edition about 20,000 copies. For popular reading, with the scientific terms avoided as far as possible. Sent to all names on the mailing list. When bulletins, more or less technical in character are issued, they are sent to the scientific institutions, but notice in regard to them is given to every name upon our mailing list, and the Station is glad to supply them to any who may wish them. The latest issue is No. 169.

BULLETINS—*Special.* Each edition, varying in number from 500 to 60,000 copies for special purposes, as occasion demands. Numbered consecutively, 1, 2, etc. Sent only to special names, as occasion demands. Latest issue is No. 53.

BULLETINS—*Press.* Each edition 600 copies. Short reading articles for newspaper columns. First number was May 24, 1890. Sent to newspaper exchanges. Latest issue is No. 85.

THE BULLETIN.—This publication is issued monthly under the supervision of the Commissioner of Agriculture, and, among other things, contains popular articles by members of the Station staff, answers to queries and other information of interest to the general public. This publication has, to a large extent, taken the place of our press bulletins.

PUBLICATIONS DURING THE YEAR.

During the period embraced by this Report, publications have been issued, divided as follows:

Annual Report of the Station—2 reports, containing 96 pages.
Biennial Report—1 report, containing 78 pages.
Regular Bulletins—18 bulletins, containing 444 pages.
Special Bulletins—4 bulletins, containing 108 pages.
Press Bulletins—7 bulletins, containing 7 pages.
The Bulletin—15 issues, containing 98 pages.
Total, 48 publications, with 831 pages.

SUMMARY OF PUBLICATIONS ISSUED FROM JULY 1, 1898 TO JUNE 30, 1899.

OF THE ANNUAL REPORTS OF THE STATION.

TWO ISSUES.

Nos. 20 and 21.—The work during 1897 and one-half of 1898 to July 1, 1898, of the North Carolina Agricultural Experiment Station.

August 1, 1898. 44 pp. Board of Control and Staff of Experiment Station. Letter of transmittal of the President of Board of Trustees, of the President of the College, and of the Director. Letter of Dr. A. C. True. Report of the Director. Scope of work. Divisions of the Station. Equipment. Experiment Station council. The working force at the Station. Publications of the Station. Summary of publications issued from January 1, 1897 to June 30, 1898. Cooperative horticultural work at Southern Pines. Examination of nursery stock. Preparation of matter for the Bulletin of the Department of Agriculture. Farmers' Institutes. Correspondence. Feeding experiments. Testing for tuberculosis. Field crop tests. Poultry keeping. Horticultural experiments. Botanical investigations. Entomological work. Experimental Chemical work. Fertilizer Control analyses. Analyses of samples for the public. Acknowledgments. Conclusion. Report of the Agricultural Division. Report of the Chemical and Fertilizer Control Divisions. Report of the Divisions of Horticulture, Botany and Entomology. Financial statements. List of recent bulletins. Bulletins 136 to 151, inclusive, issued during the year and a half ending June 30, 1898.

No. 22.—Report of the Director for the year ending June 30, 1899.

June 30, 1899. 52 pps. Letters of transmittal. Board of Trustees and Experiment Station staff. Report of the Director. Relation of the Station to the North Carolina Department of Agriculture. Relation of the Station to the North Carolina College of Agriculture and Mechanic Arts. Relation of the Station to the Fertilizer Control. Relation of the Station to the State Government. Relation of the Station to the Federal Government. The Hatch Act of March 2, 1887. Development of Experiment Station work. Scope of Station work. The ideal Experiment Station. Growth of the North Carolina Station. Changes during the year. Publications of the Station. Publications during the year. Summary of publications issued from July 1, 1898, to June 30, 1899. Cooperative Horticultural work at Southern Pines. Cooperative work with the Commission for Controlling Crop Pests. Matter for "The Bulletin." Farmers' Institutes. Correspondence. Animal nutrition. Poultry keeping. Field crops. Horticulture, Botany and Entomology. Extent of food adulteration. Methods of analysis. Analyses for the Fertilizer Control. Analyses for the public. Acknowledgments. Conclusion. Report of the Chief of the Agricultural Division. Report of the Chief of the Chemistry Division. Report of the Chief of the Divisions of Horticulture, Botany and Entomology. Report of the Chief of the Veterinary Division. Financial statement for the year ending June 30, 1899. Bulletins numbers 152 to 169 inclusive, issued during the year.

OF THE BIENNIAL REPORTS. 1 ISSUE.

No. 11.—Report for 1897 and 1898.

December 31, 1898. 78 pp. Letters of transmittal. Report of the Director Relation of the Station to the North Carolina Department of Agriculture. Relation of the Station to the North Carolina College of Agriculture and Mechanic Arts. Relation of the Station to the Fertilizer Control. Relation to the State Government. Relation to the Federal Government. The ideal Experiment Station. Growth of the North Carolina Station. Divisions of the Station. Scope of Work. Publications of the Station. Publications during the years 1897 and 1898. Summary of publications. The examination of nursery stock. Matter for "The Bulletin." Farmers' Institutes. Correspondence. Feeding experiments. Testing for tuberculosis. Field crop tests. Poultry keeping. Horticultural experiments. Botanical investigations. Entomological work. Food adulteration. Other experimental Chemical work. Veterinary work. Fertilizer Control analyses. Analyses of samples for the public.

Acknowledgments. Conclusion. Report of the Agriculturist. Report of the Chemist. Report of the Horticulturist, Botanist and Entomologist. Report of the Veterinarian. Report of the State Chemist.

OF THE REGULAR BULLETINS, 18 ISSUES.

No. 152.—Poultry Notes.

September 12, 1898. 24 pp. Disease experiments. Feeding experiment with eighteen Pekin ducks. Incubator hatches. Monthly report of poultry section. List of recent bulletins.

No. 153.—Vinegar Adulteration and the extent to which it exists in the samples for sale in North Carolina.

December 8, 1898. 8 pp. Varieties of vinegars. Adulteration and fraud. Collection of samples. Methods of analysis. Results of analysis. Conclusions. Law of North Carolina in regard to food adulteration, misbranding, etc.

No. 154.—The Adulteration of Coffee and Tea offered for sale in North Carolina.

December 17, 1898. 16 pp. Adulteration defined. Acknowledgment. Coffee. The adulteration of coffee. Examination of samples bought on the open market. Description of samples. Summary. Statistics of coffee adulteration. Tea. The adulteration of tea. Examination of samples bought on the open market. Effect of legislation on tea adulteration.

No. 155.—Baking Powders on sale in North Carolina.

December 20, 1898. 8 pp. Aeration of bread. Classification of baking powders. Collection of samples. Methods of analysis. Results of analysis. Conclusions. Recommendations.

No. 156.—The Adulteration of Flour as it is found to exist in samples purchased upon the Markets in North Carolina.

December 21, 1898. 12 pp. Acknowledgment. Flour: The adulteration of flour. Examinations of samples of flour. Percentages of ash. Summary.

No. 157.—Mineraline. An adulterant proposed for wheat flour, together with a report of some miscellaneous examinations for adulteration.

December 22, 1898. 8 pp. Introductory. Advertisement of mineraline. Information gathered. Extent of sale. Character of mineraline. Conclusion. Miscellaneous work. Coffee. Bread. Bran. Cotton-seed meal. List of recent bulletins.

No. 158.—The Fertilizer Control for 1898.

December 23, 1898. 16 pp. Introduction. Publications containing fertilizer analyses for 1898. Relation of the Station to the Fertilizer Control. Increase of number of brands and the difficulty in a proper control. Firms which registered brands in North Carolina. Extent and distribution of the trade. Valuation of fertilizers, and how they are determined. Selling price and valuations. How values per ton are calculated. Terms explained. Average percentage composition of fertilizers on sale in North Carolina. General conclusions.

No. 159.—Horticultural Experiments at Southern Pines, 1896.

December 24, 1898. 82 pp. Location of Experiment Farm. Organization. Geology. Climatic conditions. Soil. Plan of experimental tests. Fertilizers for the fruit department. The vegetable department. General results of the fruit farm for 1896. The results on individual series. General field results for the vegetable farm for 1896. Fungous and insect record for 1896.

No. 160.—Digestion Experiments.

January 18, 1899. 20 pp. Introduction. Digestion of crab-grass hay. Digestion of crab-grass hay and cowpea meal. Attempt to feed peanut meal. Digestion of crab-grass hay and corn bran. Digestion of Green Dwarf Essex rape. Digestion of crab-grass hay and rice bran. Table I, showing percentage composition of foods, waste, and solid excrement. Tables II, III, IV, V and VI, showing nutrients consumed and excreted in grams with percentages digested. Summary of coefficients of digestibility determined by North Carolina Experiment Station.

No. 161.—Drinking Water. City, Town and Rural Supplies.

January 31, 1899. 20 pp. Introduction. Purity of water. Solvent properties of water. Sources of drinking water. The construction and care of wells. The chemical analysis. Drinking water in its relation to disease. Chemical analyses of drinking waters. Notes on the table. Directions for taking samples of drinking water.

No. 162.—Farming in North Carolina. Being some hints as to the the more profitable use of Soil and Crops of the State.

March 22, 1899. 34 pp. Introductory. The errors of the past. Commercial fertilizers, their use and abuse. Home mixing of fertilizers. Our Piedmont red clay and its improvement. On a cotton farm. The Southern field or cow pea. How the pea gives us nitrogen. Stock feeding the great need of the South. Curing the pea for hay and stock feeding. The stock feeding capacity of the black pea soils of Eastern North Carolina. The sandy lands of the coast region. Care of home-made manure. Trucking as an adjunct to general farming. Pasture. Hogs for North Carolina. Hams and bacon. How to cure hams and bacon. Improving the corn crop. List of recent bulletins issued by the Station.

No. 163.—Rational Stock Feeding, including definition of terms, and composition and digestibility of foods; feeding standard; how stock rations can be calculated.

May 10, 1899. 28 pp. Definition of terms, and composition and digestibility of foods. Composition of feeding stuffs. Nutrients. Functions of nutrients. Functions of food in the animal body. The digestibility of feeding stuffs. Average composition and digestible nutrients in feeding stuffs. Coefficients of digestibility. Amount of digestible matter in feeding-stuffs. Feeding standards. Nutritive ratio. Table I, and II, feeding standards. How stock rations can be calculated. Table III, showing amount of organic substance, digestible nutrients and digestible dry matter in feeding stuffs. Table IV, coefficients of digestibility of feeding-stuffs. Table V, showing average composition of feeding-stuffs. American analyses.

No. 164.—The Flora of North Carolina from Ranunculaceae to Salviniaceae.

May 19, 1899. 80 pp. Letter of transmittal. Preface. The number of species recognized is 2,685, comprising 154 families. This brings up to June, 1899, it is believed, all well-established species within our area.

No. 165.—Preservatives in Canned Foods offered for sale in North Carolina.

June 1, 1899. 8 pp. Acknowledgment. Preservation of food by canning. Difficulties encountered in canning. Preservatives. Other foreign substances. Collection of samples. Methods of analysis. Summary of results. Description of samples.

No. 166.—Butter.

June 15, 1899. 12 pp. Introduction. Chemical composition of animal fats. Manufacture of artificial butter. Butter adulterants. Butter adulteration in North Carolina. Results in detail.

No. 167.—Poultry Experiments During 1898-'9.

June 30, 1899. 32 pp. Letter of transmittal. Table of contents. Class vs. Class, Breed vs. Breed, and Pullets vs. Hens. Rations for hens and methods of feeding. Weight of eggs. They should be sold by weight. Feeding flavor into eggs. Tables containing data of comparisons.

No. 168.—Experiments With Field and Forage Crops.

June 30, 1899. 16 pp. Seeding for pasture. Permanent improvements. Timothy seeding. Improvement of peanuts. Cotton. Comparison of varieties, 1898. Sachaline or saghalin. Prickly comfrey. Variety test of wheat, 1898-'99.

Bulletin No. 169.—Feeding Experiments and Milk Records.

June 30, 1899. 20 pp. Feeding experiments with milch cows. Daily yields and tests. Weight of cows. The cows used in experiments. I, Wheat Bran vs. Rice Bran in connection with cotton-seed meal and corn bran. II, Wheat Bran alone vs. Rice Bran alone. III, Wheat Bran vs. Rice Bran in combination with cotton-seed meal. IV, Half Wheat Middlings vs. Wheat Bran alone. V, addition of millet hay to ration of corn silage, wheat bran and pea meal (cowpea). VI, feeding experiments for milk production. VII, Wheat Bran and Cotton-seed Meal vs. Wheat Middlings and Cotton-seed Meal. VIII, Wheat Bran and Cotton-seed Meal vs. Wheat Bran alone. Milk records at Experiment farm.

OF THE SPECIAL BULLETINS. 4 ISSUES.

No. 50.—The Station and its Exhibit.

October 25, 1898. 10 pp. Pamphlet descriptive of the work of the Station and its exhibit at the Annual Fair of the North Carolina Agricultural Society.

No. 51.—Catalogue of Herbarium Specimens for Exchange.

December 16, 1898. 48 pp.

No. 52.—Cattle Quarantine Line.

January 10, 1899. 30 pp. Letter of transmittal. Regulations concerning cattle transportation. North Carolina State laws. Proclamation of the Governor of the State of North Carolina, quarantining certain localities on account of Texas fever. Special order modifying quarantine line for the State of North Carolina. Dr. Curtice on quarantine law. Dipping process abandoned. Report on present conditions. Virginia State law. Proposed laws.

No. 53.—Food Adulteration in North Carolina.

January 17, 1899. 20 pp. Preface. Vinegar. Baking powders. Coffee. Tea. Sugar. Flour. Canned goods. Extent. An act to prevent the sale of adulterated and misbranded food, and to amend and make effective the provisions of chapter one hundred and twenty-two, Laws of one thousand eight hundred and ninety-five.

OF THE PRESS BULLETINS, 7 ISSUES.

No. 79.—October 6, 1898. 1 p.

Medicinal Plants. Note concerning bulletin No. 150.

No. 80.—November 1, 1898. 1 p.

Experiment Station Report. Note concerning report for twentieth and twenty-first years.

No. 81.—November 9, 1898. 1 p.

Poultry Notes. Notice of bulletin No. 152.

No. 82.—January 1, 1899. 1 p.

Coffee and Tea Adulteration. Note concerning bulletin No. 154.

No. 83.—January 1, 1899. 1 p.

Baking Powders. Note concerning bulletin No. 155.

No. 84.—January 1, 1899. 1 p.

Vinegars. Note concerning bulletin No. 153.

No. 85.—March 12, 1899. 1 p.

Food Adulteration. Note concerning special bulletin No. 53.

THE BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION OF NORTH CAROLINA, 15 ISSUES.

July 1, 1898. 16 pp.

Fertilizer analyses for 1898. Handling of strawberry beds. Fertilizers, rotation of crops, separators, etc. Rust fungus on apples. Hessian fly, wheat, etc. Northern nursery stock for North Carolina. Turning under clover, etc. Best time to cut peas for forage. Fertilizer for cow-peas. Balanced ration for milch cows. Fertilizer for peas and wheat. System of cultivation and rotation. Table containing 421 fertilizer analyses for the North Carolina Department of Agriculture.

August 1, 1898. 5 pp.

Examination of drinking water. For poultry raisers. Inspection of nursery stock. Food adulteration. Nut grass. Cow-peas and crimson clover. Strawberry mildew, black spot, etc. Curing corn, etc. Fertilizer for sweet potatoes. Sheep raising, pasture, etc. Fire-blight. Cultivation of wheat. Handling strawberry beds. Rust fungus. List of recent Experiment Station Bulletins.

September 1, 1898. 4 pp.

Botanizing in Mitchell County. Sale of cow—what is she worth? Manure for wheat. Treatment for land subject to overflow. Cutting and shocking corn again. Where to grow currants. Asparagus rust.

October 1, 1898. 6½pp.

Notes to nurserymen and purchasers of nursery stock. The disposal of tuberculous cattle. List of nurserymen outside of the State who have filed certificates of official examination. List of nurserymen licensed to do business in North Carolina. A six-year rotation of crops. Pea-vine curing, Irish potatoes, etc. Milk with an offensive odor. Pasture grasses. Cattle bloat. A remedy for oyster-shell scale. Wheat and clover. A remedy for sun scald. Apple twig borer. Celery blight, figs, etc.

November 1, 1898. 6½pp.

Experiment Station report. Dosing liquid remedies. Poultry notes. Rye for soiling. List of nurserymen licensed to do business in North Carolina. List of nurserymen outside of the State who have filed certificates of official examination. National Pure Food and Drug Congress. Do agricultural colleges seduce from the farm? Table containing thirty-seven fertilizer analyses for the North Carolina Department of Agriculture.

December 1, 1898. 6½ pp.

Remedy for cockroaches. Remedy for weevils. How to pickle beef. Curing pea-vine hay. Fertilizer for peaches and strawberries. A canning outfit. Drainage, etc. Pea-vines and how to use them. Distemper in horses. Some trouble in milch cows. Crimson clover and drill worms. Table containing eighty fertilizer analyses for the North Carolina Department of Agriculture.

January 1, 1899. 6 pp.

Coffee and tea adulteration. Baking powders. Vinegars. Mahogany. Mulberry cuttings. Table containing one hundred and seventy fertilizer analyses for the North Carolina Department of Agriculture.

February 1, 1899. 2½ pp.

Cotton or what? Table containing twenty-three fertilizer analyses for the North Carolina Department of Agriculture.

March 1, 1899. 5½ pp.

Black walnuts and pecans. Land improvement, poultry, etc. Grass for pasture. Water tank and shredded corn. Explanation of terms used in connection with the analysis of fertilizers. Table containing seventy-eight fertilizer analyses for the Department of Agriculture.

March 15, 1899. 5½ pp.

The composition of commercial fertilizers. Fertilizer for asparagus. African cane. Creamery and cheese factory. Table containing one hundred and twenty-two fertilizer analyses for the North Carolina Department of Agriculture.

April 1, 1899. 5 pp.

Table containing one hundred and seventy-five fertilizer analyses for the North Carolina Department of Agriculture.

April 15, 1899. 5½ pp.

Table containing one hundred and ninety-two analyses for the North Carolina Department of Agriculture.

May 1, 1899. $6\frac{1}{2}$ pp.

Food adulteration. Table containing two hundred and fifty-four fertilizer analyses for the North Carolina Department of Agriculture.

May 15, 1899. $7\frac{1}{2}$ pp.

Table containing two hundred and eighty-two fertilizer analyses for the North Carolina Department of Agriculture.

June 1, 1899. $9\frac{1}{2}$ pp.

Table containing three hundred and eighty-five fertilizer analyses for the North Carolina Department of Agriculture. (Complete table for the spring samples.)

COOPERATIVE HORTICULTURAL WORK AT SOUTHERN PINES.

The Experimental Farms at Southern Pines were established to study the effects of different proportions of nitrogen, phosphoric acid and potash, and the proportions best suited for the fruit and vegetable crops grown in that section. On October 31, 1898, by order of the Board of Trustees the Experiment Station withdrew from connection with the Farms, which up to that time had been under the management of a Supervising Committee, composed of the representatives of the State Horticultural Society, the Experiment Station and the German Kali Works. Up to the time of the withdrawal the Chemical work and the Horticultural work in the way of supervision were performed without compensation by the members of the Station staff and the other expenses of the Farm were borne by the German Kali Works. The work of the Station during the year up to October 31st consisted of the supervising work, and various analyses of products of 1898, the preparing of an exhibit at the Omaha Exposition and the preparation of the report for 1896. The Experiment Station claims no credit for, and assumes no responsibility for any work on the Farms since October 31, 1898, or for any publications subsequent to the report for 1896.

COOPERATIVE WORK WITH THE COMMISSION FOR CONTROLLING CROP PESTS.

This Commission established by Act of the General Assembly of 1897 consists o fthe Commissioner of Agriculture, the Director of the Agricultural Experiment Station and the President of the State Horticultural Society. The Commission is charged with the inspection of the nurseries of the State, the supervision of the shipment of nursery stock, and is empowered to adopt such regulations as may be deemed necessary to suppress and prevent the spread of dangerous crop pests. The Director of the Experiment Station has been the Chairman of the Commission and its executive officer.

The appropriation by the State is just about sufficient to defray the

expenses of inspection of nurseries, but is inadequate to provide for any help for the owners of orchards. This is a critical time for the fruit growers' interests as there is great danger from the spread of the San Jose scale and other dangerous pests, and it is noted with great pleasure that our State Department of Agriculture has decided to come to the aid of the Commission.

On June 24, 1899, the Acting Director of the Experiment Station tendered his resignation as Chairman of the Commission and Hon. S. L. Patterson, Commissioner of Agriculture, was elected in his stead. It is hoped that with the help of the Agricultural Department the work of the Commission will be enlarged and prove of the greatest benefit to the nurserymen and fruit growers of the State.

MATTER FOR "THE BULLETIN."

The Bulletin of the Agricultural Experiment Station of North Carolina, a monthly publication, is prepared and circulated under the supervision of the North Carolina Department of Agriculture. It contains in addition to matter which is furnished by the Department of Agriculture, various articles of popular interest relating to the Experiment Station and analyses of fertilizers by the State Chemist. During the past year the Experiment Station furnished 83 articles and 12 tables containing analyses of fertilizers and covering in all 98 pages of printed matter.

FARMERS' INSTITUTES.

Farmers' Institutes were held during the summer of 1898 in twenty-nine counties under the auspices of the Department of Agriculture. By invitation of the Commissioner of Agriculture the Experiment Station participates in this work and with few exceptions had some representative present at every Institute. The attendance at these meetings was not large, and in consequence the benefits were not so great as they would have been with a better attendance. It is believed that great good may be accomplished in this way.

CORRESPONDENCE.

The Station is always glad to receive letters from citizens of the State seeking further information in regard to agriculture. These letters are referred to the member of the Station staff to whose work they relate more closely. These letters and the requests for our bulletins average about thirty for each working day in the year. We feel that such a mass of correspondence serves to bring our work into close contact with our farmers, and we trust it has proven a stimulus to them in their work.

ANIMAL NUTRITION.

During the past year some digestion experiments were repeated by the Agricultural and Chemical Divisions, with a view to comparing the results with mature sheep and the results previously obtained with the same sheep when younger.

Some experiments by the Agricultural and Chemical Divisions with milch cows to test the effect of feeds on the quality of butter have been completed.

Some experiments by the Chemical Division are in progress with a view to ascertaining the digestibility of the various nutrients in feeding stuffs. So far the work has related only pentosans, sucrose and dextrose.

The Agricultural Division soiled some sheep on rape, cowpea, vetch and rye.

ANIMAL DISEASES.

The Veterinarian did not enter upon his duties until October 16, 1898, and was given leave of absence after March 15th to enter the service of the State Department of Agriculture.

The Veterinarian has prepared a bulletin on the Cattle Quarantine Line, and has called the attention of our General Assembly to various needed amendments to our laws in regard to the diseases of farm animals. The General Assembly of 1899 afforded much needed relief along the lines mentioned.

Our people need to give attention particularly to the study of the means to eradicate Tuberculosis and Texas Fever in cattle. Our Veterinarian is now doing for the people of the State, under the auspices of the Department of Agriculture, the work which he planned during his connection with the Experiment Station, but which for lack of means it was not possible to perform.

The Agriculturist has also on hand data gathered at the expense of much time, relating to Tuberculosis and Cattle Ticks.

POULTRY KEEPING.

The poultry work is carried on at a disadvantage in so far as the demonstration of the profitable side of the industry is concerned, since the birds are kept in enclosed places, and do not have a range, and since there are no scraps for feeding, as would be the case under ordinary farm conditions.

The young stock has been culled by the Agriculturist and the culls sold for table use. The cold weather demonstrated the necessity of keeping the houses close to the ground and providing means for shutting up tight so as to prevent frosting of the birds. A series of rations, to be repeated at intervals, has been devised, and it seems to be satisfactory. The Agriculturist has attempted the study of the

egg yield of individual hens, and also a comparison of feeds for egg and for flesh production. Difficulty has been encountered by sparrows getting a portion of the feed.

FIELD CROPS.

The work with field crops during the past year has been interfered with by the loss of an assistant.

The crops experimented with by the Agricultural Division were peanuts—to see if the number of peas per pod can be increased by selection; with cowpeas—a variety test in comparison with velvet beans, and several legumes from the Indian Ocean; with cotton—a varieyt test; and with wheat—a variety test of seeds grown in this State.

The Agricultural and Chemical Divisions have in progress an experiment with corn, cotton and sweet potatoes, and crimson clover, which will involve a study of the effect of a rotation, and a renovating crop, together with the manurial requirements of these crops.

The Chemical Division has distributed a great many pounds of sugar beet seed to the farmers of the State, with a view to testing the adaptability of the State to the production of the sugar beet as a feed for stock.

HORTICULTURE.

The Horticulturist complains of lack of land for the proper prosecution of his work, and it is hoped land can be assigned him without interfering with other work. During the past year, the forest-tree seedlings were removed from Southern Pines to Raleigh, when the Station work terminated there. These trees will be used to beautify the College grounds. The lily bulbs were also removed and planted on the lands of Capt. B. P. Williamson. Many bulbs have been grown for another season's planting, and if the result proves successful it will mean much to our people. Small experiments by the Horticulturist in the forcing of tomatoes and cucumbers under glass seem to indicate that this may become an important part of the work of our market gardeners in the future.

BOTANY AND ENTOMOLOGY.

The Botanical and Entomological Divisions have identified such plants and insects as were sent to the Station for identification. Advice was given as to the means of destroying such insects and pests as were injurious.

The Station herbarium has been enriched with the collection by the Assistant Botanist.

The Assistant Botanist has prepared and published as Bulletin No. 164, the flora of the State, from Ranunculaceae to Salviniaceae.

EXTENT OF FOOD ADULTERATION.

The Chemical Division has collected and analyzed samples of the most important classes of food materials, and has published the results of the work in eight bulletins which relate to vinegar, baking powders, coffee and tea, flour, mineraline, canned foods, butter and the general subject of food adulteration. A bill was framed by this Division and enacted into law by the General Assembly of 1899, establishing for the first time in the history of the State a Food Control, under the Board of Agriculture, similar to the Fertilizer Control.

METHODS OF ANALYSIS.

The Chemical Division has cooperated with the Association of Official Agricultural Chemists in a study of methods of agricultural analysis with a view to improving the same. The work during the past year related to sugars, phosphoric acid, potash, nitrogen and its availability, etc.

ANALYSES FOR THE FERTILIZER CONTROL.

During the year the Fertilizer Control Division analyzed 569 samples of fertilizers received from the Commissioner of Agriculture, and published the results in the monthly bulletin. These bulletins were distributed to the names on the mailing list of the Department and to all others who applied.

ANALYSES FOR THE PUBLIC.

During the past year the Fertilizer Control Division has made analyses of 324 samples which were sent by the citizens. There is no appropriation for this purpose, but the Station has been glad to extend the courtesy in the past.

After June 30, 1899, the Experiment Station will receive its entire support from the Hatch fund, and it will be impossible to continue this work. Such work has been provided for, however, by the State Agricultural Department, and in future samples for analysis and communications relating thereto, should be addressed to the State Chemist and not to the Experiment Station.

ACKNOWLEDGMENTS.

The Station takes pleasure in acknowedging the receipt of the books and pamphlets, journals and newspapers stated below. The reports and bulletins of the United States Department of Agriculture, and of various Experiment Stations in the different States, Canada and abroad are not included in the list, but are regularly received.

Boston Public Library. Report of the Trustees for 1897.
University of Iowa. Bulletin No. 3, Vol. 4, Laboratories of Natural History.

Georgia Department of Agriculture. Publications, 1898.
New Jersey Dairy Commissioner. Report for 1896.
Iowa Dairy Commissioner. Report for 1897.
Wisconsin Dairy and Food Commission. Biennial Report for 1895-1896.
North Dakota State Dairymen's Association. Second Annual Report.
Michigan Dairy and Food Commission. Bulletins.
California Dairy Bureau. First Annual Report.
Massachusetts Horticultural Society. Transactions 1897, Part 2; 1898, Part 1.
J. S. Wright, Secretary, Indiana Academy of Science. Proceedings for 1897.
Secretary of the Royal Agricultural Society, London, England. Journal, Vol. 9, Parts 3 and 4.
Secretary of the Kansas State Board of Agriculture. Report for third quarter of 1898; first quarter of 1899. Eleventh Biennial Report 1897-1898.
United States Geological Survey. Bulletins Nos. 88, 89, 149. Monograph No. 30.
Secretary of the Wisconsin Dairymen's Association. Twenty-sixth Annual Report.
Augustana College, Rock Island, Ill. The Mechanical Composition of Wind Deposits.
T. J. Fitzpatrick, Lamoni, Iowa. The Drift Section and the Glacial Striae in the Vicinity of Lamoni, Iowa. Notes on the Flora of Northeastern Iowa.
Hon. W. H. Worth, Raleigh, N. C. Report of the Condition of the State, Private and Savings Banks at the Close of Business, September 20, 1898.
Pres't H. S. Hartzog, Clemson College, S. C. The Mission of Clemson.
Propaganda for Nitrate of Soda, New York. Nitrate of Soda as a Fertilizer.
Secretary of the Maine State Board of Health. Report for 1896 and 1897.
Librarian, American Museum of Natural History. Bulletin, Vol. 10.
Commissioner of Agriculture and Labor of North Dakota. Report for 1898.
United States National Museum. Proceedings, Vol. 20.
Department of State. Commercial Relations of the United States. Two volumes.
George McKerrow, Superintendent Wisconsin Farmers' Institutes, Madison. Bulletin No. 12.
United States National Museum. Bulletin No. 47, Parts 2 and 3.
New York State Entomologist. Reports 13th and 14th.
T. Jameson, Aberdeen, Scotland. Proceedings of the Agricultural Research Association, 1898.
United States National Museum. Report for 1896.
Frank Russell, University of Iowa. Explorations in the Far North.
Conway Macmillan. Minnesota Botanical Studies, Second Series, Part 2.
American Manufacturer and Iron World. March 17, 1899.
New York State Geologist. Report for 1895.
R. H. Lewis, Secretary North Carolina State Board of Health. Seventh Biennial Report, 1897-1898.
C. H. Mebane, Superintendent. Educational Report of North Carolina for 1896-97, 1897-98.
H. E. Dosch, Secretary. Report of Oregon Board of Horticulture, 1897-1898.
S. P. Langley, Secretary, Smithsonian Institution, Washington, D. C. Reports for 1896 and 1897.
L. A. Goodman, Secretary. Missouri State Horticultural Society. Report for 1898.
Secretary, Memphis Cotton Exchange. Directory and Book of Reference.
Commissioner, North Carolina Bureau of Labor Statistics. Eleventh and Twelfth Annual Reports for 1897 and 1898.
Commissioner, Arkansas Bureau of Mines, Manufactures and Agriculture, 1897 and 1898.
Secretary, New Jersey Board of Agriculture. Twenty-sixth Annual Report for 1898.

United States Geological Survey. Eighteenth Annual Report, 1896-97. Parts 1, 2, 3 and 4.

C. F. Martin, Secretary. National Live Stock Association. Proceedings of Second Annual Convention, 1899.

William Trelease, Director. Missouri Botanical Garden. Tenth Report for 1899.

Wm. R. Sessions, Secretary, Boston, Mass. Agriculture of Massachusetts for 1898.

Meteorological Service of Canada. Report for 1896. Two volumes.

Commissioner, Albany, N. Y. New York Department of Agriculture. Report 1897. Three volumes.

PAPERS AND JOURNALS OUTSIDE THE STATE.

Agricultural Epitomist	Indianapolis, Ind.
Agricultural Gazette of New South Wales	Sydney, Australia.
American Cultivator	Boston, Mass.
American Dairyman	New York, N. Y.
American Florist	Chicago, Ill.
American Grange Bulletin and Scientific Farmer	Cincinnati, Ohio.
American Grocer	New York, N. Y.
Baltimore Sun (weekly)	Baltimore, Md.
California Cultivator and Poultry Keeper	Los Angeles, Cal.
Cordage Trade Journal	New York, N. Y.
Cotton Ginners' Journal	Waco, Texas.
Cotton Planters' Journal	Memphis, Tenn.
Elgin Dairy Report	Elgin, Ill.
Farm and Home	Springfield, Mass.
Farm and Home	Melbourne, Australia.
Farm and Fireside	Springfield, Ohio.
Farm, Field and Fireside	Chicago, Ill.
Farm, Furnace and Factory	Roanoke, Va.
Farm Journal	Philadelphia, Pa.
Farmers' Advocate	Burlington, Vermont.
Farmers' Advocate	London, Ontario.
Farmers' Guide	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Magazine	Springfield, Ill.
Farming	Toronto, Ontario.
Gleanings in Bee Culture	Medina, Ohio.
Hoard's Dairyman	Fort Atkinson, Wis.
Home and Farm	Louisville, Ky.
Homestead	Des Moines, Iowa.
Hospodar	Omaha, Neb.
Indiana Farmer	Indianapolis, Ind.
Jersey Bulletin	Indianapolis, Ind.
Louisiana Planter	New Orleans, La.
Mirror and Farmer	Manchester, N. H.
Montana Fruit Grower	Missoula, Mont.
National Stockman and Farmer	Pittsburg, Pa.
New England Florist	Boston, Mass.
New York Weekly Witness	New York, N. Y.
Northwest Horticulturist	Tacoma, Wash.
Practical Farmer	Philadelphia, Pa.
Public Ledger	Philadelphia, Pa.
Rural Californian	Los Angeles, Cal.
Sanitary Inspector	Augusta, Me.
Southern Farmer	New Orleans, La.
Southern Farm Magazine	Baltimore, Md.
Southwest	Springfield, Mo.
Southwestern Farmer	Wichita, Kansas.
Sugar Beet	Philadelphia, Pa.
Swine Breeders' Journal	Indianapolis, Ind.
The Ruralist	Gluckheim, Md.
The Western Creamery	San Francisco, Cal.

Tobacco Leaf	New York, N. Y.
Trade Journal	Baltimore, Md.
Tri-State Farmer and Gardener	Chattanooga, Tenn.
Wallace Farmer	Ames, Iowa.
Weekly Times	Melbourne, Australia.
Western Fruit Grower	St. Joseph, Mo.
Western Swineherd	Genesee, Ill.
West Virginia Farm Review	Charleston, W. Va.

PAPERS RECEIVED FROM INSIDE THE STATE.

Alamance Gleaner (Graham).
Asheville Citizen.
Bulletin North Carolina Board of Health (Raleigh).
Caucasian (Raleigh).
Carolina Fruit and Truck Growers' Journal (Wilmington).
Carolina Record (Red Springs).
Times-Democrat (Charlotte).
Concord Times.
Curfew (Abshers).
Dixie Dairyman (Wilson).
Economist-Falcon (Elizabeth City).
Eastern Reflector (Greenville).
Elkin Times.
Foods and Helps (Southern Pines).
Free Press (Kinston).
Greensboro Patriot.
Henderson Gold Leaf.
Hickory Press.
Morganton Herald.
North Carolina Baptist (Fayetteville).
North Carolina Medical Journal (Wilmington).
Roanoke News (Weldon).
Smithfield Herald.
Standard (Concord).
Statesville Landmark.
Sylvan Valley News (Brevard).
Tarboro Southerner.
The Commonwealth (Scotland Neck).
Union Republican (Winston).
Washington Gazette.
Wilson Times.
Yankee Settler (Southern Pines).

CONCLUSION.

The work of the year has been performed under many difficulties. The Agricultural Division has needed the service of another assistant; the Horticulturist needs lands adequate for his work; the Entomological Division, as far as experimental work is concerned, has had practically only a nominal existence; the Chemical Division has suffered from the frequent changes in the staff during the year; the Veterinary Division was in actual existence only about long enough to plan work. Only the Fertilizer Control and the Botanical Divisions have labored without unfavorable conditions. Yet notwithstanding these disadvantages it is hoped that much of value has been accomplished for the advancemens of agriculture. In this connection the Acting Director wishes to bear testimony to the faithfulness and zeal of the members of the staff, which have made these results possible.

The year has also been one of change in organization which always causes unrest. The cooperation in the work at Southern Pines has ceased; the Chemical work has been separated from the Fertilizer Control work and removed to the College buildings; the executive work of the Commission for Controlling Crop Pests has been transferred to the Commissioner of Agriculture.

At the close of this fiscal year the Fertilizer Control work will be transferred to the immediate supervision of the Department of Agri-

culture and all the members of the Station staff will be engaged in College work.

During the first decade of the Station's existence it was removed from the University grounds at Chapel Hill to the Agricultural Building in Ralegh, and it underwent a change of Directors. During its second decade it was transferred from the management of the Board of Agriculture to the Board of Trustees of the College, there was another change of Directors, it suffered and almost ceased work on account of an adverse Federal decision, but later its scope of usefulness was enlarged by the passage of the Hatch Act. At the beginning of its third decade, there is another change in the Directory, two almost entire changes are made in the staff, a transfer of the Station to the College grounds is made, there is an abandonment of all police work, and a closer connection between the Teaching and the Experiment Station Departments of the College.

Notwithstanding these changes the Experiment Station has a history of which it may be justly proud. As the years go by new problems will present themselves for solution. It is believed that these will be approached with the same zeal that has characterized the work of the past.

The reports of the chiefs of the various divisions are appended hereto as a part of this report.

REPORT OF THE CHIEF OF THE AGRICULTURAL DIVISION.

PROF. W. A. WITHERS, *Acting Director.*

SIR:—During the summer of 1898 the Agriculturist attended Farmers' Institutes all the time which could be spared from routine duties. This work and delays in the transmittal of the Electrical Apparatus prevented its installation for taking the soil temperature and soil moisture this year.

Following the Institute work came the resignation of Mr. F. E. Hege, Poultry Manager, which threw the details of that section on the Agriculturist, and it has proven a never failing place for the expenditure of time and energy.

The stock was put in an improving condition the previous year, by Mr. Hege, under our advice and direction. To further the progress made, the young stock was freely culled and culls have been sold for table use. The best has been retained and sold as breeding stock. To this end, after careful work had been done in selection, Mr. Hege gave us the benefit of his expert knowledge as a poultry judge, and scored nearly all of the breeding stock selected for the present year.

Some diseases—malaria ?—among the birds gave much trouble in the fall and early winter. Circumstantial evidence pointed to the Fair Ground well-water as the source of this trouble, and a change from that to a cistern as the source of water relieved the birds of the disease, and stopped the loss of fowls.

Some crowding together of the large number of growing young birds in small, cheap shelters,caused the other trouble which destroyed some birds, but gave a greater loss of time in treating the sick than the loss of birds amounted to.

The severe cold weather accompanying the heavy fall of snow demonstrated the necessity of keeping all chicken houses close to the ground and of providing even cheap houses with means of shutting up tight enough, and with little enough of overhead room to prevent severe frosting of the birds. As it was, the heavy snow prevented our suffering very severe losses of birds. The warning is plain, however, and he who winters fowls in summer and fine weather houses in our climate, usually so mild, invites disaster when its low extreme falls on his exposed stock.

Feeding the breeding stock has of necessity given us many hours of close application, and in order to save ourselves from too many and perplexing changes in keeping records of what was done to keep the birds supplied with appetizing food suitable for egg production we have devised a series of rations which are repeated at intervals

and which seem to be perfectly satisfactory. We are preparing a bulletin giving these rations in detail.

The large stock, and rather light sales made it necessary to start rather more yards than was desirable this spring in order to profit by their presence and secure the eggs which were inevitable in as valuable condition as possible. Spring sales have been more satisfactory and stock has been reduced back to nearer what it was last year in numbers but it is better now than it was then.

We think some satisfactory progress has been made, and also that our stock is on a higher plane than a year ago.

There has been a step taken toward individual egg records, and we should aim to individualize in experiments and eliminate some sources of error in order to make experiments of more value. For instance we attempted to feed a ration to a yard of nine birds. What is known of their individuality? Or how their needs to produce eggs are supplied when one grows thin whilst another becomes so exceedingly fat as to die of excessive fatness, when both have free access to the same amounts of the same feed?

Again, who can tell with any degree of accuracy, what is the effect of any given ration in the production of meat or eggs, when the ration is divided between the birds for which it was intended and an unknown number of sparrows. (Passer domesticus. Linn)?

These are open questions as are those of the greatest production of eggs or flesh for a given amount of food consumed between breeds, or strains of one breed, or individuals within a strain and which we may develop and prove out some points of very great economic value to the community.

For instance in one yard we have frequently found that large and small eggs were being laid by hens very nearly alike and which scored high in the hands of an expert judge of poultry.

The small eggs sell for the same price per dozen, the hen may or may not consume as much food as her sisters laying larger eggs, but her tray will be justly shunned by purchasers.

It is information on these points we are commissioned to seek. Since January 1st we have carefully weighed all eggs daily and have some data already accumulated as to weight of eggs of the breeds kept, in regard to season—by months—and comparison can be made of the weights of eggs produced by pullets and mature hens within several of the breeds.

With the nest boxes to indicate individual egg records some data closer than any hitherto possible can be obtained and this division has started investigation in this direction.

Our duties as Professor of Agriculture have necessarily consumed about half of the time a man can work. The other half has been put in the line of stock feeding and breeding, administration, correspondence, and a little to other things. Consequently there has

been little done with field crops which, to grow and keep the proper track of changes in detail, is exacting of time on the part of the observer. We need an assistant who will be allotted this work under direction. Last year we had one fairly started when he went into the army. This lost this Division some notes which would have added value to work in hand.

An experiment with peanuts was carried out last year and has been started again this year to be repeated again and again to find if the number of seeds per pod can be increased by inheritance.

A variety test of cowpeas was grown last year in comparison with velvet beans and several legumes from Prof. Angust de Villil , on de l' Ilede la Reunion, in the Indian Ocean. None of these last bore seed. One variety is being grown again hoping it will mature seed this year.

A variety experiment with potatoes proved a failure from the late delivery of seed.

A comparison of two varieties of cotton has been made. A variety test of ten leading varieties of cotton is now in progress.

A rotation of three leading summer crops, corn, cotton and sweet potatoes, with commercial manure on some plats and a winter covering of a renovating crop has been started to test the exhaustion of soil on unmanured land under these conditions—carried on in connection with the Chemical Division.

A variety test of wheat, the seed of which was obtained from growers in this State, has just been harvested.

Sheep have been soiled on rape, cowpea, vetch and rye.

Some feeding experiments with cows have been conducted and several digestion experiments repeated with the same matured sheep with which they were first made as young sheep—carried on in connection with the Chemical Division.

The crop of lambs for 1898 were mainly lost by parasites, probaby the same as have been so disastrously troubling northern breeders. Medicines are indirect and not satisfactory. The lambs this year are being nearly isolated and the old feeding ground plowed up. We hope to raise more lambs this year. There were 35 fleeces clipped and 20 lambs are now on the farm.

The number of lambs is considerably less than it would have been if suitable care could have been given them. The lack of funds and placing this Division on so rigid a basis for the past few months has necessitated dropping what might have been, for what *must* be done, and too cheap help had to be entrusted with care of stock, to our loss.

Stock on hand June 20, 1899, is as follows:

Driving horse, Charles, purchased in 1889.

Two work horses.

One shorthorn bull, three years old.

Two shorthorn cows.

One shorthorn heifer.

Three grade cows: One shorthorn, one Jersey, one common.

One grade Jersey heifer.

One registered Jersey heifer.

SHEEP.

Two wethers used in digestion experiments.

Three rams: Merino (Spanish Delaine), Dorset, Southdown.

Three Merino ewes (Spanish Delaine).

One Dorset ewe.

One Southdown ewe.

Twenty-four grades and natives.

Twenty lambs both grades and pure bred.

POULTRY SECTION JUNE 1ST.

One hundred and fifty-one birds constituting the breeding stock.

Reserve and culls 32. Three hundred chickens.

The publications of this Division have not, of course, been as numerous and important as would have been the case had not half the time been devoted to College work. We have, however, put in print the following bulletins:

Poultry Notes, by F. E. Hege.

Digestive Experiments, by F. E. Emery.

Revision of Bulletin No. 106, by F. E. Emery and J. M. Johnson, and nearly ready, Report of Professor of Agriculture and Agriculturist to Experiment Station to Board of Trustees Committee.

Feeding Experiments with Milch Cows, by F. E. Emery and J. M. Johnson, (in cooperation with Chemical Division). (*In preparation.*)

Poultry Feeding Experiments and Egg Records, by F. E. Emery. (*In preparation.*)

This Division also has on hand to be written up by Dr. Curtice data gathered at considerable expense for time, on Tuberculosis and Cattle Ticks.

This would have been in print before now but for disturbing causes.

Recommendations.—The selection, *by the Agriculturist,* of an assistant to take crop notes and do some clerical work; the installation of the Electrical Apparatus; and reduction of Poultry Section by discarding stock which shall be indicated by records when compiled sufficiently to show the least as well as most promising stock to develop on experimental lines.

Respectfully,

F. E. EMERY,
Agriculturist.

REPORT OF THE CHIEF OF THE CHEMICAL DIVISION.

During the year the work of this Division has been vigorously prosecuted. It has been the aim of the Division to perform all the analytical work necessary in connection with the work in which the other Divisions of the Station cooperate, and in addition to prosecute independently other investigations relating to the agricultural interests. This work is included under the following heads:

Fertilizers for Fruit and Vegetable Crops.—This work has been performed under the name of the Experimental Farm of the North Carolina State Horticultural Society. The Horticulturist and the Chemist represent the Experiment Station on the Supervising Committee having charge of the work.

The following analytical work was performed by this Division:

32 samples of Raspberries 4 samples of Blackberries	in which phosphoric acid, nitrogen and potash were determined.
19 samples of Tobacco	in which moisture, phosphoric acid, nitrogen, potash and nicotine were determined.
28 samples of Blackberries 20 samples of Beans 20 samples of White potatoes	in which nitrogen was determined.
32 samples of Grapes, in which dextrose was determined.	
155	

The report for 1896 was prepared and issued as bulletin No. 159.

Digestibility of Feeding Stuffs.—This work was performed in cooperation with the Agricultural Division, the Agriculturist having in his charge the feeding and collection of excrements and waste, and the care of the animals; the Chemist having in charge the analytical work. These experiments are still in progress but the following determinations are completed:

2 samples of silage 2 samples of waste 2 samples of excrement	in which moisture, ether extract, crude fiber, and ash were determined.
6	

The Quality of Butter as Affected by the Feed of the Cow.—This work was performed in cooperation with the Agricultural Division, that Division being responsible for the work in the stables and dairy, the Chemist being responsible for the work in the laboratory. The rations of the animals were changed from time to time and analyses of the butter were made at frequent intervals to ascertain the effect of a change of feed and the length of time required for the change. This work is still in progress, but the following determinations are completed:

9 samples of butter: determinations specific gravity, volatile acids and saponification number.

The Nature and Extent of Food Adulteration.—This work has been finished and the results are embodied in seven regular bulletins, and one special bulletin. It was found that nearly every class of food is subject to adulteration or sophistication, and that the adulteration is to be found principally in the foods which are consumed by the poor. The work of this Division was brought to the attention of the General Assembly, and the need of legislation was so evident that the bill drawn by this Division and introduced by the Hon. S. L. Patterson, of Caldwell, was enacted into law and goes into effect August 1, 1899. In this connection it is proper to make our acknowledgments to the several prominent gentlemen of Raleigh and other parts of the State who gave their influence to the passage of the bill, and to the press of the State which generally showed the greatest interest in the subject. The analytical work included:

20 samples of vinegar.
29 samples of coffee.
9 samples of tea.
25 samples of baking powder.
39 samples of canned goods.
56 samples of flour.
18 samples of butter.
3 samples of fruit preservative.
2 samples of bran.
1 sample of bread.
1 sample of unfermented grape juice.

203

Methods of Agricultural Analysis.—This work is performed in connection with the Association of Official Agricultural Chemists—which Association is composed of the Chemists of the Experiment Stations, Agricultural Colleges, Boards of Agriculture, etc. Samples are sent out each year for analysis by the Referees of the Association. The samples examined during the year just ending were:

1 sample of beet molasses, for water, ash, reducing sugar, sucrose, and raffinose.
5 samples of fertilizing materials, for phosphoric acid by gravimetric and volumetric methods.
3 samples of fertilizing materials, for potash and moisture.
19 samples of fertilizing materials, for determining the availability for plants of the nitrogenous matter.
1 sample of milk, for determining casein and albumen.
1 sample of peas, for galactan.

30

Experiments with Sugar Beets.—This work was begun during the spring of 1898, with a view to ascertain if the conditions in the State were favorable to the growth of the beet as a feed for stock. During the fall of 1898 samples grown in various portions of the State were analyzed and in some cases it was found that it was possi-

ble to produce a beet with about 13 per cent. of sugar. During the spring of 1899 beet seeds were distributed to various farmers in quantities sufficient to plant half an acre. During the coming fall samples will be analyzed and the farmers will be requested to furnish reports of their experience. The analytical work during the past year was:

50 samples of beets, for sucrose, specific gravity and purity ratio.

Digestibility of Nutrients.—This work has practically just begun. The object is to determine the digestibility of some of the constituents of the feed. The analytical work so far has been only:

4 samples of green rape, for pentosans.

Fertilizer Requirements of Crops.—This work was begun during the spring of 1899. Fifteen plots at the Experiment Farm have been set aside for this work, and cotton, corn, and sweet potatoes, have been planted. There is a variation in the amount of fertilizing ingredients applied to the different plots. The Agricultural Division is cooperating with this Division in this work.

During December, 1898, the work of this Division was transferred from the Agricultural Department building in Raleigh to the main building of the College, much to the convenience of the staff.

The analytical work was performed under the direction of the Chemist by Messrs. H. K. Miller, J. M. Pickel, G. S. Fraps, J. A. Bizzell and H. W. Primrose. The writer wishes to make public acknowledgment of the value of their work.

Very respectfully,

W. A. Withers,
Chemist.

REPORT OF THE CHIEF OF THE DIVISIONS OF HORTICULTURE, BOTANY AND ENTOMOLOGY.

Prof. W. A. Withers, *Acting Director:*

I herewith submit my report for these Divisions of the Station work for the past year.

HORTICULTURAL.

During the past year no Horticultural work was inaugurated at the Southern Pines farms except the regular work of the committee and an experiment with varieties of melons from the Department of Agriculture at Washington. Owing to the peculiarities of the season and the character of the soil, the melon experiments were a failure. The forest tree work was continued during the season, and when the Station was withdrawn from the work at Southern Pines the bulbs and trees were all removed to Raleigh. Having no land here for my purposes, a large part of the experiments with bulbs, to the extent of ten thousand lily bulbs, was continued on land rented for the purpose from Capt. B. P. Williamson. The exceedingly cold winter was very unfavorable to the bulbs, but the crop was a fair one and we have secured a very large number of young bulbs for another season's planting, which will probably give better results. The forest tree seedlings were planted at the College, but with the present season there seems to be an inclination on the part of the Forestry Division of the Department of Agriculture at Washington to abandon further work in this line. We will grow the trees on hand for planting on the College grounds. With the abandonment of the work at Southern Pines, my assistant, Mr. Rhodes, returned to Raleigh the first of December last. I was hoping that the Board would see the necessity for equipping the Horticultural Department with land and team for the doing of some real work in this line. I have, as I have said, endeavored to keep up the work with bulbs by renting land. It would seem that the interests of the truckers and fruit growers of the State are of sufficient importance to call for some experiments in their interest, and the constant inquiries made of me in regard to new fruits and vegetables which people assume are being tested at the Station, are very embarrassing when I have to reply that I know nothing about them, as I have no garden grounds for testing them, and no team to cultivate it with if I had. It is to be hoped that this difficulty will soon be remedied. and the Horticultural work of the Station put on a footing with other of the Divisions.

The correspondence in this line has been heavy during the year, and

we have answered all inquiries so far as we were able. The past winter was very severe on many things, but plants are recovering rapidly, and the experience has been a good one in the getting of knowledge in regard to the comparative hardiness of plants here. It has shown plainly that many plants that are cultivated in greenhouses North, can be grown here with perfect safety in the open ground. Chinese Azaleas and Camellias came through the winter unhurt. Pomegranates were cut somewhat by the cold, but not seriously injured. The Chinese sweet olive was badly cut, but is again growing vigorously. Pittosporum Tobirum came through with slight injury, and we find that there are many of the broad-leaved evergreen shrubs that can well be added to our collections. It is hoped that with room and means we can renew the experiments with the Chinese tea plants that were begun years ago. In 1894 we grew one thousand tea plants and sent them to Mr. Andrew Broadfoot at Fayetteville for experiment. They were well cared for and were coming into a good condition for experimental trials when some vandal at night chopped the whole plantation down to the ground. The great success that has attended the culture of tea in South Carolina makes it of interest that experiments should be made with the plant in Eastern North Carolina, and it may be that a new industry can be added to the coast region. The present Secretary of Agriculture is taking an active interest in this matter and it is reported that the Department is preparing to distribute a large number of plants. We hope that we may be favored with a quantity for trial.

Small experiments in the forcing of tomatoes and cucumbers under glass seem to indicate that this may become an important part of the work of our market gardeners in the future. We hope the coming winter to make a comparative test of the varieties best suited to forcing, and to give the results commercially of the culture.

BOTANICAL.

The Station herbarium was greatly enriched last summer by the vacation collections of my botanical assistant, Mr. C. W. Hyams. It has been further added to by exchanges from this collection with Botanists in other parts of the country, so that we have now a very respectable herbarium that will be useful in the identification of plants sent for study. We have made a great many identifications of grasses and other plants sent in by correspondents during the year. Mr. Hyams published last year a list of the plants of North Carolina that have been used for medicinal purposes and has prepared and published a complete flora of the State.

ENTOMOLOGICAL.

This Division has identified many insects sent in by farmers and others during the year, and we have in all cases, where possible, given

advice as to the prevention or destruction of those that are injurious to crops. The necessity for having fruit and other plantations of our own for the study of the various means for combating the insects that attack trees and plants of all kinds is imperative if the Station is to be of the use it should be to the fruit growers of the State. But until we have the means for this study, little can be done except to profit by the experience of Stations where the work of the Horticulturist and Entomologist is considered to be of some importance, and where the means for doing something of value are afforded to the head of the work. It is to be hoped that by the time another annual report is to be prepared, the Division of Horticulture, Botany and Entomology in the North Carolina Station will have to report that it has been allowed means for doing its work.

Respectfully,

W. F. Massey,
Horticulturist, Botanist and Entomologist.

REPORT OF THE CHIEF OF THE VETERINARY DIVISION.

Prof. W. A. Withers, *Acting Director.*

Sir:—I have the honor to report as follows regarding present and future work in this Division.

Since my appointment, October 15th, I have been engaged in answering inquiries and studying the local needs of the cattle industry.

I found on my arrival that much work had been done in eradicating tuberculosis from the herds of the Experiment Station and College of Agriculture and Mechanic Arts, and that much important material is ready for a report thereon. The experimental work was performed by the Professor of Agriculture, Frank E. Emery. Prof. Emery has, besides, secured the examination of several other herds of this State with the gratifying result of finding no disease.

A recent examination of the herd of the North Carolina State Insane Asylum developed the fact that six out of twenty-seven adult cattle were tuberculous. These were set aside and further contamination of the herd from them prevented.

An inspection of the records at hand indicates that the disease has been comparatively recently imported into the State with Northern thoroughbred cattle. It is probable that but few herds are infected.

The results suggest two lines of action: First, that a law be passed prohibiting the importation of cattle from without the State unless accompanied by certificate of tuberculin examination, approved by proper authorities of the State whence the animal is to be imported, and of this State; second, that herds supplying public institutions with milk, or belonging to those institutions, be examined, both as to the presence of disease and as to sanitary surroundings.

Since cattle affected with tuberculosis often exchange hands while in apparent health, and subsequently die, I recommend that when the evidence shows that the animal was tuberculous at the time of exchange, that the last owner may collect the value exchanged, if necessary by process of law. A special law to this effect would be just.

There is in this State a quarantine line placed along the Blue Ridge by this State, at the instance of the United States, for preventing cattle crossing from the Piedmont region to the mountain plateau and valley lands. This quarantine is said to be necessary on account of the presence of cattle ticks on cattle east of the line, which ticks carry a disease and inoculate it into cattle bred and raised west of the line. It has lately been reported that the United

States Bureau of Animal Industry, under whose control the supervision of the line is placed, has perfected plans of dipping cattle that remove the ticks and permit them to enter into free trade with other localities.

Should it be possible to establish dipping stations for this purpose, the cattle traffic of the western portion of this State will derive much profit and be able to drive cattle at all seasons, when it is now restricted to two or three months. This important matter should be closely investigated by this Station.

Since it is conceded by the Bureau of Animal Industry that cattle without ticks may be admitted from the quarantined territory, it becomes highly important to be sure that the quarantine line does not exclude cattle which are entitled to free traffic on account of being from non-infected territory. It becomes necessary, moreover, to demonstrate methods of exterminating ticks from farms, that they may not be perpetually quarantined. The numerous outbreaks of disease in cattle occurring when they are changed from place to place in this State, from the same reasons sought to be prevented by the quarantine line, suggests the possibility of preventing the disease entirely by the eradication of ticks. Experiments performed a few years since by the Georgia Experiment Station conclusively proved that Northern cattle could be successfully pastured on Southern pastures where there were no cattle ticks, even though the cattle were introduced in midsummer from the North.

The successful execution of experiments in tick eradication under the varied conditions of stock raising means a saving of thousands of dollars annually to the State and a continued prosperity from the successful rearing and improvement of neat cattle.

An inquiry recently addressed to the Station developed the fact that the machinery of the legislation against glanders in horses was deficient.

The present law regarding distemper in cattle is of little use, as it is directed not toward the cattle which spread the disease, but toward those which contract it and die.

This is the disease known to the Federal Government as Texas fever, and legislation affecting it should be on plans preventing spread of that disease.

A law prohibiting the driving of cattle or horses carrying ticks on the highways of this State would go far toward preventing disease.

For the future investigation of disease and diagnostic purposes, as well as for general purposes in biologic investigation in connection with the Experiment Station, a laboratory equipped with microscopical and bacteriologic apparatus is necessary. For the present there is little need of other buildings or grounds usually connected with pathologic work. The farm must be the experimental field, and the problems arising in actual practice must be solved on them.

Closet or laboratory experiment has already proceeded far beyond the practical needs in certain directions, and application of the results of experiments is needed, especially with tuberculosis, Texas fever, anthrax, symptomatic anthrax, glanders and hog cholera. The practical application of the results of scientific work has not yet passed out of the experimental stage, and this Station may well engage in it.

In thus reviewing diseases which may be to some extent in the State, there is but one which demands unremitting attention, and that is the one for which cattle are quarantined, Texas fever. The second in importance, though I believe it to be comparatively rare, is Tuberculosis.

I am, sir, your obedient servant,

COOPER CURTICE,
Veterinarian.

REPORT OF THE CHIEF OF THE FERTILIZER CONTROL DIVISION.

PROF. W. A. WITHERS, *Acting Director*.

DEAR SIR:—I present herewith a report of the work of the Fertilizer Control Division for the year ending June 30, 1899.

OFFICIAL FERTILIZERS RECEIVED FROM COMMISSIONER OF AGRICULTURE.

Acid Phosphates	144
Acid Phosphates with Potash	68
Ammoniated Superphosphates with Potash	323
Miscellaneous	34
Total	569

SAMPLES FOR THE PUBLIC.

Health Waters	122
Mineral Waters	39
Fertilizers	23
Flour	3
Rock	8
Cotton-seed Meal	7
Agricultural Lime	1
Marl	7
Fertilizing Materials	20
Lime	3
Phosphate Rock	1
Phosphatic Lime	1
Soil	2
Cave Earth	1
Talc	1
Sulphur in Iron Pyrites	1
Worm Dust	1
Boiler Water	1
Indian Vat	1
Hulls of Velvet Beans	2
Bean Pods	1
Ores, Minerals and Rocks identified and values reported	78

EXPERIMENTAL WORK ON PHOSPHATES CONTAINING IRON AND ALUMINA.

Total Phosphoric Acid (Determinations)	151
Insoluble Phosphoric Acid (Determinations)	134
Calcium Oxide (Determinations)	10
Oxide of Iron (Determination)	39

In addition to the work indicated by the above report, the Division has devoted considerable time to the investigation of methods to be used in the analysis of phosphates containing much iron and alumina, and has also cooperated in the work of the Association of Official Agricultural Chemists.

THE ANALYSIS OF DRINKING WATER.

The setting apart of a special room for this work has enabled us to give it more attention than heretofore, and has also made possible a more thorough examination and a fuller report upon each sample.

One hundred and twenty-two samples have been analyzed during the past year. The increasing demand for this kind of work will eventually require the time of one analyst, should the present arrangement of making these analyses free of charge be continued.

ANALYSES FOR THE PUBLIC.

The State makes no appropriation for this work and consequently only a limited amount can be undertaken. The regulations require that it be of an agricultural character, that samples be taken according to directions furnished by the Experiment Station, and that the Station be allowed to publish the results. No work of this nature can be undertaken at times when it would interfere with the regular work of the Division. During the year just ended 324 samples have been analyzed for the public. Of these 122 were drinking waters, 39 mineral waters, 78 identification of ores, minerals, etc., and the remainder were fertilizing materials and miscellaneous samples.

ANALYSES FOR THE FERTILIZER CONTROL.

The number of commercial fertilizers submitted for analysis by the Commissioner of Agriculture continues to increase. During the year ending June 30, 1898, 556 samples were analyzed, while during the year ending June 30, 1899, 569 samples have been analyzed. These samples were taken by agents sent out by the Commissioner of Agriculture and represent nearly three-fourths of the brands registered in the State.

PUBLICATIONS.

In addition to the analyses of the commercial fertilizers which have been published regularly in the bulletin issued under the supervision of the Department of Agriculture, this Division has prepared for publication two bulletins—one on the "Fertilizer Control for 1898," and one on "Drinking Water."

I can not conclude the report without referring to the Assistant Chemists, who have faithfully, promptly and accurately done the work which has been assigned to them.

Very respectfully,

A. W. Blair,
State Chemist.

FINANCIAL STATEMENT OF THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1899.

RECEIPTS.

From the Treasurer of the United States (Hatch fund)	$15,000.00
" " N. C. Department of Agriculture (for analysis of fertilizers)	14,166.66
" " sale of farm products	864.76
" miscellaneous sales	303.94
Total receipts	$30,345.36

EXPENDITURES.

	Hatch fund.	Fertilizer fund.	Farm Products.	Misc.	Total.
Salaries	$9,069.35	$10,674.58	$365.08	-------	$20,109.01
Labor	1,548.99	696.54	129.08	-------	2,374.61
Publications	2,042.88	101.30	-------	-------	2,144.18
Postage and stationery	423.48	195.74	157.77	-------	776.99
Freight and express	10.87	115.91	55.65	-------	182.43
Heat, light and water	----------	205.01	56.25	-------	261.26
Chemical supplies	62.45	1,072.07	8.25	-------	1,142.77
Seeds, plants and sundry supplies	37.38	55.60	27.80	-------	120.78
Fertilizers	----------	----------	11.15	-------	11.15
Feeding stuffs	912.18	19.50	45.56	-------	977.24
Library	118.57	21.62	18.17	$79.40	237.76
Tools, implements and machinery	23.70	71.25	-------	40.63	135.58
Furniture and fixtures	365.81	122.54	-------	105.70	594.05
Scientific apparatus	37.60	112.04	-------	5.02	154.66
Live stock	183.25	----------	-------	9.38	192.63
Traveling expenses	----------	376.94	-------	11.50	388.44
Contingent expenses	138.00	210.65	-------	46.03	394.68
Building and repairs	25.49	115.37	-------	6.28	147.14
Total expenditures	$15,000.00	$14,166.66	$874.76	$303.94	$30,345.36

Examined and found correct.

E. Y. WEBB,
J. B. STOKES,
Finance Committee.

BULLETIN NO. 152 SEPTEMBER 12, 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

Poultry Notes.

F. E. HEGE.

1. DISEASE EXPERIMENTS,
2. A FEEDING EXPERIMENT WITH PEKIN DUCKS,
3. INCUBATOR RECORDS.

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M	Professor of Chemistry.
F. E. EMERY, M. S	Professor of Agriculture.
W. F. MASSEY, C. E	Professor of Horticulture.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.

F. E. EMERY, M. S	Agriculturist.
W. F. MASSEY, C. E	Horticulturist.
A. W. BLAIR, A. M	State Chemist.
C. B. WILLIAMS, M. S	Assistant Chemist.
H. K. MILLER, M. S	Assistant Chemist.
C. D. HARRIS, B. S	Assistant Chemist.
J. A. BIZZELL, B. S	Assistant Chemist.
F. G. KELLY	Assistant Chemist.
G. S. FRAPS, B. S	Assistant Chemist.
ALEX. RHODES (Southern Pines)	Assistant Horticulturist.
C. W. HYAMS	Assistant Botanist.
J. M. JOHNSON, M. S.	Assistant Agriculturist.
B. S. SKINNER	Farm Superintendent.
J. M. FIX	Secretary.
H. E. KING	Chief Clerk.
C. M. HUGHES, B. E	Clerk.
MISS M. S. BIRDSONG	Stenographer.
MRS. L. V. DARBY	Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

AGRICULTURAL DIVISION.

RALEIGH, N. C., Sept. 12, 1898.

SIR :—I have the honor of presenting the accompanying manuscript, which is recommended to be published as a bulletin from the Poultry Section of this Division. This comprises some cases of several diseases, showing simple treatment and how to avoid the disease; a record of the cost of raising eighteen Pekin Ducks to market size and several incubator records, with a condensed monthly report as a guide to parties wishing to learn to bring the month's transactions to view in a condensed way.

This may be of great value to people who have fowls sick from common diseases, as indicating how to avoid, as well as to treat, the diseases in a simple way.

The incubator records are not without value to amateurs in artificial incubation.

Respectfully,

FRANK E. EMERY,
Agriculturist.

PROF. W. A. WITHERS,
Acting Director.

POULTRY NOTES.

F. E. HEGE, POULTRYMAN.

This bulletin represents a portion of the work done in the Poultry Section from July 12, 1897, to July 12, 1898, and it may be advisable to briefly outline or describe the surroundings and stock in this department.

From the beginning it has been deemed advisable to use the simplest houses, cheapest fences and feed-stuff that are to be had on all farms.

The houses are not identical; eight were built after plans which appeared in Bulletin 130 (page 209), the remainder were made in different ways—by utilizing old boxes or old lumber of any kind, being careful to see that they did not leak, that the floors were dry, and that they faced south or southeast. The fences in use were made by using rough pine plank at bottom, two feet high, stretching four feet two in mesh-woven wire above, making a height of six feet, which is ample for most breeds, though it is always advisable during the breeding season to clip one wing of all the smaller breeds to insure them remaining within their enclosure. The size of the yards, with the exception of Nos. 1, 2 and 3, (which were allowed full liberty) was 25x150 feet. The latter yards are devoid of grass, excepting a growth of wire-grass and weeds, which appeared late in spring. The character of the soil is red clay, and, as it was impossible to utilize any other space, the greater number of the yards are entirely too damp for best results, which causes not only very badly soiled plumage, but retards egg production. Most of the breeding stock having been purchased; their ages were uncertain, though they were said to be yearlings. It now seems certain that many of them were two to four years old.

The general health of the entire number has been very fair, no serious sickness occurring.

For all yards of fowls the following health precautions have been observed:

Houses whitewashed inside in spring, and cleaned once per week regularly, at each time covering the floor with slaked lime; roost poles saturated weekly with either kerosene oil, kerosene emulsion, or any other insectecide that was on hand. Yards are plowed frequently in some parts, a growth of weeds in remaining portion left for shade. The breeders were dusted with insect

powder every sixty days. Fresh water supplied three times per day in summer and twice per day in winter.

For an incubator cellar a room on the N. E. corner of office building was used, the floor having been removed, and an inside partition erected, leaving a dead air space of several inches between. The brooder house is an ordinary shed-like structure 10x27 feet, 9½ feet front, 6 feet back, the front containing several 4 light sashes. The roof is covered with shingles, the sides are rough pine plank, joints broken with three-inch stuff; floor, dirt, raised 6 inches above the outside level. This house is divided into 5 divisions; the runs are 9x40 feet. In this house 3 home-made and 2 ready-made brooders are used.

Other articles of great value to the Poultry Section are—

One green bone-cutter.

One hand-mill for crushing oyster shells, cracking wheat, corn, etc.

One hand grit-crusher.

One home-made cracked-corn sifter, which gives us three separate grades; (sifts twenty pounds per minute).

One home-made furnace for steaming clover, boiling meat, etc.

A complete system of electric bells, used as burglar alarms.

A cheap set of carpenters tools, one fire pot, soldering irons, solder, etc.

Our feeding bins are glucose barrels, placed on second floor, each having a tin spout extending into feed-room below. There are several other home-made appliances that simplify labor. As to the laying records appearing, while the average is small and not up to the claims of many, the following obstacles were against us:

1. Yards devoid of green stuff.
2. Inability to obtain green bones.
3. The old age of a large number of the hens.

In addition to the above we have every reason to believe that a number of eggs, weekly, were stolen.

Taking all above in consideration, there is no doubt but that fowls one and two years old given their liberty, where there is an abundance of green food, a much larger per cent could easily be obtained.

I. Disease Experiments.

The disease experiments were all made, with few exceptions, on fowls, the property of private individuals, and not on the stock in the Poultry Section of Experiment Farm.

With the exception of several mild cases of roup, which occurred only among the fowls that had for their roosting quarters a large open house, the opportunities for such work has been limited. We have been very fortunate, so far, in avoiding any serious sickness

among the fowls here, and might add that we attribute the fact to the following precautions, or methods:

1. All grown fowls are watered in strictly clean vessels twice per day in winter and three times in summer months, being very careful that in summer all such vessels are placed in the shade. Young fowls are watered five times daily.

2. That war is waged on vermin continually.

3. That good, wholesome, sound food is always given, *and at regular hours.*

4. That coarse lime, gravel or grit, and charcoal are continually before all fowls. Oyster shells are also occasionally supplied, but we do not consider the latter an absolute necessity.

5. That all houses are cleaned and floors limed once per week in winter and two and three times in summer.

6. That no food is left lying around to sour, and care is taken to feed only as much as will be eaten promptly.

7. That all fowl-houses have perfectly tight roofs, and the north, east and west sides are closed so as to avoid draughts. Fronts are covered with wire netting.

The reader will notice that all remedies applied are simple—only such as are in the household of almost every family and on all farms. While there are many patented articles that are prepared especially to effect the desired cures, many of them cannot be had in case of an emergency; therefore, if such articles figured in the diseases treated at the Experiment Station, many valuable fowls owned by readers of Station publications would succumb before the article could be ordered, if the owner even desired same.

The matter of treating diseases in fowls is one much discussed in the poultry papers, but from personal observations will say that *unless* the *fowl* first attacked is a *valuable* one, the hatchet will be of more service to you than the fowl when cured, as the chances of spreading the disease among other fowls and the time devoted to effect the cure, will, nine out of ten cases, be worth more than the fowl. Follow above measures, as in vogue at the Station, and sickness among the flocks will be a rare occurrence.

DIARRHŒA.

In summer months, especially while the grown fowls are in moult (taking on a new coat of feathers), the strain on their system is great, frequently resulting in serious cases of bowel trouble. Only five cases of any importance came under our observation during the late summer of 1897, and were treated as follows:

No. 1. Langshan hen; August 15, 1897. The feathers under her vent was noticed covered with the discharge. She stood around in the shade and refused to eat; was cooped in a cool place,

and given one tablespoonful of sweet oil, which cleaned her system thoroughly. On the evening of the 16th food was placed before her, which she failed to touch. On the 17th a small amount of cut bone was given, which she ate, but seemed very weak. On the 18th fresh-cut clover was placed in her cage, and one pint of water to which had been added one teaspoonful of Jamaica ginger. The grass was eaten and a few sips of water were taken, but no other food. On the 19th, finely-cracked corn was given, after trying her on soft food, to which had been added 15 per cent. of powdered chalk. A small quantity of corn was eaten. On the 20th, cut bone was added to a mixture of wheat bran and corn meal, of which she ate heartily, afterwards eating nicely at regular feeding hours, viz.: morning and night. On the 22d her bowels were in normal condition, appetite good, and was returned to yard.

At the same time No. 1 was detected as sick, another (No. 2), in the same yard, was affected in like manner, but was allowed to remain in the yard until August 18. She was then cooped, and, after treating as before for ten days, died.

No. 3. A Langshan hen, from same yard, August 30; affected as Nos. 1 and 2 were; immediately cooped and treated as the foregoing ones, and was returned to the yard on September 3.

No. 4. Barred Plymouth Rock hen, September 7th; was missed and finally found in lower end of yard, so weak she could not walk. Cooped her and gave four grains of calomel and dusted with insect powder. 8th, Seemed much stronger, though ate but little, and would not touch water. 9th, Better, comb again brightening and appetite good. 10th, Stronger, seeming in good health; was returned to yard.

No. 5. Light Bramah cock, September 7; a very serious case. Cooped and gave one tablespoonful sweet oil, to which was added two grains calomel. By morning of 8th he was brighter, and was eating grass sod that had been placed in coop the evening previous. No further attention was paid him, except to feed morning and night with soft food, to which had been added 10 per cent. of black pepper. September 11 returned him to yard.

From above, and from experience previously, for years, it seems that, if taken in time, a cleansing of the system by the use of either sweet oil or calomel, followed by soft food containing, say, 10 per cent. black pepper (or less, if the fowl will not consume as much as 10 per cent. in feed), will almost invariably effect a cure, but if the trouble is not noticed at once, cures are infrequent. What causes the occasional cases in the yard has not been determined, unless, as stated before, the fowl in moulting is naturally weaker than when in full feather. No severe cases have appeared except during the moulting season.

Sorehead Experiments.

July 17, common hen and seven chicks, six weeks old were brought to the Station. Their heads were covered with sores; the eyes of hen and four chicks were closed. They were treated as follows:

Each one placed in separate coop.

No. 1 (hen). Scabs scraped off and pine tar applied once per day for eight days. Fourth day, eyes opened. Tenth day, all sores disappeared. She was fed by hand until eyes opened, and pronounced cured on 29. Time, twelve days.

No. 2 (chick). Eyes closed; scabs scraped off. Applied strong alum water daily and fed by hand until July 24, when eyes opened. Three new sores appeared, but made no advance after being scraped. July 30, was well. Time, thirteen days.

No. 3 (chick). Eyes closed; scabs scraped, and bluestone touched to each place at 7 a. m., and 4 p. m. Head bathed in a solution of same. July 23, head was in good condition, and nothing more was done. Time, six days.

No. 4 (chick). Eyes closed; scabs scraped, and bluestone touched every evening for three days, then discontinued. Head in good condition on July 22. Time, five days.

No. 5 (chick). Eyes closed; scraped scabs and applied daily (evenings) carbolized vaseline. This seemed to have but little effect until July 24, when no new sores appeared and eyes opened slightly; 28th eyes were opened wide and though the old scabs remained, no further signs appeared. This chick became very weak, but was judged as well on 30th. Time, thirteen days.

No. 6 (chick). Eyes open, but head well covered with sores; scraped scabs, and applied iodine daily. Was well on July 23. Time, six days.

No. 7 (chick). Eyes open; only three sores on head. Scraped scabs and covered entire head daily with ordinary axle-grease. No new sores appeared, and the old ones did not enlarge. Discontinued greasing on July 26; well on 29. Time, nine days.

No. 8 (chick). Eyes open, but head practically covered with sores. Scraped scabs and bathed head three times daily in very strong bluestone water until 20th, then discontinued and chick was well on 22d. Time, five days.

Four common-grown fowls that had been running at a slaughter house were treated as follows:

Placed in separate coops in an outhouse August 10.

No. 1. Very fat and full of vermin, head one perfect sore, in fact, so bad that it did not seem advisable to try to remove the scab. Gave a tablespoonful of sweet oil, dusted her well with insect powder, and bathed head twice daily with strong bluestone

water, to which had been added three drops carbolic acid to each one-half pint. Fed her by hand on soft food. For five days there was no noticeable improvement. On the seventh day a small portion of the scab dropped off and the bare place was powdered with pulverized bluestone. Ninth day a large piece of scab came off and the head was again rubbed with the powdered bluestone. On the twelfth day the head was clear of sores and healed over. No feathers ever appeared on head afterwards, and one eye was destroyed. Time, twelve days

No. 2. Very fat and filled with vermin. Head only partially covered with sores, and only one eye closed. The scabs were scraped and powdered, bluestone applied the first day, and for four days after bathed entire head in bluestone water. She was well seven days.

No. 3. Both eyes closed and very thin in flesh, having been without food for several days. Considered her as a hopeless case, but applied vaseline the first day twice, to soften scabs, then for three days, bathed her head in alum water. Could not force food down her throat only by prying mouth open and pushing it down into the crops. The fifth day she died.

No. 4. In fair condition, full of vermin. One eye closed, only one side of head being affected. Scraped sores, and after bathing the entire head in warm soapsuds applied bluestone (powdered,) mixed with a small per cent. of vaseline to insure it to stick. Only two applications were made. On the fourth day she was considered well. Time, four days.

Sorehead is a serious drawback to poultry-raisers in the South, and if the disease strikes a flock during June or July, nothing could do the fowls more damage, as it is extremely contagious, apparently well fowls one day covered with sores on the head the next.

The cause of sorehead yet remains a mystery, though there seems to be a prevailing opinion that it is caused by impurities in the blood. That opinion is sustained by the writer's experience, as follows: Several years since, over 100 fowls, both old and young, succumbed to the disease in his yards, and neighbors also lost great numbers. The next season, March 1, I began mixing powdered sulphur in morning food for all fowls three times per week (½ pint to each ½ gallon of food) and adding twice per week ¼ pint epsom salts to each gallon of drinking water, continuing same until about October 1. Since that time I have had no cases, yet neighbors who did not use any precautions buried their fowls daily.

Sorehead in winter is indeed a rare occurrence, and that is another indication that stagnant blood is really the prime cause of the disease. Sulphur and salts both act on the system of the fowl, cleansing it from almost any lingering disease germs.

Roup.

Dec. 18. Three Plymouth Rock cockerels, with slight colds, discharging at nostrils only; thin in flesh; were placed in coops in a warm room; nostrils were cleaned daily, and two drops camphorated oil inserted; also gave a two-grain quinine pill daily. There was no perceptable change up to the 25th. They had been fed on regular morning mash at 7 A. M. At night cracked corn was given (all they would eat clean). Dec. 26, discontinued using camphorated oil and quinine, and began bathing heads daily with kerosene oil, and adding one ounce pepper to each quart of soft feed. A change for the better was noticeable by the eve of 27th. Next day being quite cold, they seemed droopy, but ate their feed very well. This latter treatment was continued until Jan. 10, 1898, when they were released in good health, but still thin in flesh. No return of the disease afterwards. Weights as follows: When cooped, 5.6, 5.4, 6; when released, 5.9, 5.15, 6.8.

Oct. 17, 1897. An Indian Game pullet, from miscellaneous yard, contracted a deep cold, which caused heavy discharge from nostrils and her throat to be filled with slime, so much in fact that she could breathe only with greatest difficulty. She was cooped at once; nostrils cleaned and camphorated oil inserted; her throat was thoroughly swabbed with kerosene oil daily, but did not improve. 25th, gave one teaspoonful salts. 26th, bowels very loose. 28th, much better, throat being free from any slime, and discharge at nostrils had discontinued. I then placed two more pullets in same cage affected in similar manner, but not as far advanced. Applied to throat and nostrils kerosene oil daily. During the whole period they were fed just as if at liberty, supplying, of course, grit and green food. All were released Nov. 10, being in perfect health.

November 17, 1897. An Indian Game cockerel running in miscellaneous yard was missed, and after a search was found under the feed room, with both eyes closed, face swelled badly. A very offensive odor from nostrils was noticeable at a distance of four feet. He was very much emaciated, and so weak he could scarcely stand. A coop was prepared and placed in office near the stove, and, after giving him a teaspoonful of epsom salts, his head was washed daily for four days with strong salt water. A two-grain quinine pill was given daily until November 22. As he could not see to eat for the first six days, he was fed four times daily on a small quantity of morning feed. November 23, eyes opened, and appetite better; discharge from nostrils less. The daily application of salt water was continued. He improved rapidly until the 28th, when eyes and nostrils were in normal condition, and but for being thin in flesh, was in good condition. The weather being

cold, did not liberate him until November 30, 7 A. M. By evening his eyes were again watering badly, which proved that he was turned out in the cold air too early. Re-cooped him, and on December 11 released, being in fine shape. His weight, when cooped, November 17, was 3.2; when released, December 11, 4.

Above cockerel had been roosting under the feed-room, where cold winds could strike him from north and west.

December 15. When separating the fowls that occupied the large Fair Building, quite a number of younger fowls were found that had colds and were very thin in flesh. Six Plymouth Rock cockerels were placed in a large cage, and heads and nostrils daily bathed in pure kerosene oil. Half an ounce of epsom salts was put in their drinking water every other day. They were fed on soft food twice daily, to which had been added a liberal quantity (one ounce to each quart) of black pepper. They improved rapidly, and were released December 26. Total weight cooped, 33 pounds; when released, 46 pounds. Neither one showed any signs of cold afterwards. Their roosting quarters were changed to a less exposed place on December 24.

December 18, 1897, several fowls, running in miscellaneous yards, were noticed affected with colds, and three were selected and placed in a large cage in a room free from draughts.

The cage was first well disinfected with carbolic acid, floor covered with coarse sand and a top dressing of pine straw. Grit, oyster shells and charcoal were placed before them, together with fresh water once per day. With the sick fowls one healthy Langshan pullet was placed in order to see if she would contract the disease after coming in actual contact with them. Below are names of breed, weight when first isolated and when released:

	Weight when isolated.	Weight when released.
Indian Game Cockerel	6.2	6.6
Black Langshan pullet	5.1	5.4
White Wyandotte pullet	4.8	5.
Healthy Langshane pullet	5.8	5.12

No medicine was given during the fourteen days of confinement. Their roosting quarters was near an open door facing the west, consequently there is no doubt but that the cold night air, blowing directly on them, was the cause of the disease. When first noticed, their eyes were full of bubbles, which is seen so often by poultrymen, and at their nostrils was a slimy, offensive discharge, with an apparent dead appearance of feathers, and an inclination to stand quietly in warm corners during the day.

Their feed during the above period was the usual morning mash, composed of one-third each (by bulk) corn meal, wheat bran and

middlings. For evening feed, corn, oats, ground bone and wheat was given alternately. A tuft of green grass was thrown in cage daily.

December 24. The eyes of each one was free from any foreign matter, but discharge at nostrils was still apparent, but of less quantity.

December 28. Discharging at nostrils still less, and odor noticed but little.

December 31. All discharges have ceased, and their health seemed as perfect as could be, hence they were released.

The healthy pullet that was placed in the cage was allowed to remain until January 15, 1898, to determine if she would contract the disease from eating and drinking from the same vessels that were used by the affected fowls. She remained in perfect health and began laying on January 12.

From above facts, there is no doubt that the colds which had developed into mild cases of roup were caused by roosting where the chilly night air was continually upon them. We do not recommend giving no medicines in cases as above, but simply tried it to note results, and are satisfied that if the fowls are placed in positions not exposed to draughts, that the disease is not necessarily contagious. Previous experiments made by the writer, in 1891 and 1892, fully convinced him of the foregoing. There can be little doubt but that if a laxative had been given the three subjects when first isolated, and nostrils had been cleansed daily, their period of confinement would have been decreased by several days.

II. A Feeding Experiment With Eighteen Pekin Ducks.

The following table shows the amount fed above ducks for fifty-six days, showing hours when fed, etc. In addition to the soft food tabulated, fine grit one-sixth the weight was added, also about one-fourth the bulk in green clover, chopped fine. The whole mass was mixed with water until in a crumbly state, not soggy. This was fed in troughs. No water was allowed except an abundance of pure drinking water. During the entire time none were sick. No doubt they could have been grown larger by adding vegetables to their food, but as potatoes were very high, it did not seem advisable to use them.

SUMMARY.

Average weight when hatched		2	ozs.
" " " 1 week old		2½	ozs.
" " " 3 "		6¾	ozs.
" " " 4 "		15½	ozs.
" " " 5 "	1 lb.,	15	ozs.
" " " 6 "		3	lbs.
" " " 7 "	3 lbs.	14	ozs.
" " " 8 "	4 lbs.	15½	ozs.

Total cost at eight weeks—

	Cents.
Corn meal—141.95 lbs., at 1c. per lb	141.95
Wheat bran—1181 lbs., at 9-10c. per lb	107.01
Cut bone—67.22 lbs., at 1c. per lb	67.22
Grit—54.66 lbs., at 1c. per lb	54.66
Green clover—estimated cost	20.00
Food for hens carrying ducks	17.00
Value of eggs	37.00
Total	444.84
Average cost each at eight weeks	24.71 cents
Cost per pound " "	5.05 "

Not counted—labor or ground rent.

We might add that this lot of ducks was sold for 50 cents each.

Food Given Eighteen Pekin Ducks for 56 Days.

(ALL WEIGHTS IN GRAMMES.)

1898.		7 A. M.			9 A. M.		11 A. M.			1 P. M.		3 P. M.			6 P. M.	
		Meal.		Bran.	Meal	Bran	Meal		Bran	Meal	Bran	Meal		Bran	Meal	Bran
Mar.	29	20		20	20	20	15		15	25	25	25		25	20	20
	30	25		25	20	20	15		15	30	30	25		25	20	20
	31	30		30	25	25	20		20	30	30	25		25	25	25
April	1	50		50	50	25	40		30	50	50	50		50	60	60
	2	50		50	50	25	40		30	50	50	50		50	60	60
	3	70		70	60	50	50		40	50	50	50		50	70	70
	4	85		85	70	70	Discontinued			75	75	60		60	80	80
	5	100		100	80	80	...		...	90	90	70		70	100	100
	6	110		100	80	80	...		...	90	90	70		70	100	100
	7	130		130	90	90	...		...	110	110	85		85	150	150
	8	150		150	100	100	...		...	125	125	90		90	150	150
	9	150		150	100	100	...		...	125	125	90		90	150	150
	10	180		180	100	100	...		...	175	175	90		90	175	175
	11	180		180	120	120	...		...	175	100	90		90	175	175
	12	200		100	150	100	Bone		....	175	100	90		90	200	150
	13	200		100	150	100	100		....	175	120	90		90	200	150
	14	200		120	150	100	100		....	175	120	100		50	200	100
	15	200		120	150	100	100		....	175	120	100		70	200	100
	16	220		150	150	100	100		....	175	120	100		70	200	100
	17	220		150	150	100	100		....	175	120	100		70	200	100
	18	220		150	150	75	150		....	175	120	100		70	200	100
	19	250		175	150	75	200		....	150	100	100		70	250	150
	20	250		175	150	75	200		....	150	100	100		70	250	150
	21	300		200	150	75	250		....	150	100	100		70	250	150
	22	300		200	150	75	250		....	150	100	100		70	250	150
	23	300		200	175	100	250		....	150	100	100		70	250	150
	24	350		250	Discon-		300		....	150	100	100		70	250	150
	25	350		250	tinued		400		Bran	Discon-		100		70	350	250
	26	400		300	...		400		100	tinued		200		150	350	250
	27	400		300	...		400		100	...		200		150	350	250
	28	400		300	...		400		100	...		200		150	350	250
	29	450		350	...		500		100	...		200		150	400	300
	30	450		350	...		500		100	...		200		150	400	300
May	1	450		350	...		500		100	...		200		150	400	300
	2	450		300	...		500		100	...		200		150	400	300
	3	450		300	...		400		100	...		200		150	400	300
	4	450		300	...		400		100	...		200		150	400	300
	5	500		300	...		400		100	...		200		150	400	300
	6	500		300	...		400		100	...		200		150	400	300
		Meal	Bone	Bran	...		Bone	Bran	Meal	...		Meal	Bone	Bran		
	7	550	300	400	...		500	100	100	...		300	200	200	400	300
	8	550	300	400	...		600	100	100	...		350	200	250	400	300
	9	550	300	400	...		600	100	100	...		350	200	250	400	300
	10	550	300	400	...		600	100	100	...		350	200	250	400	300
	11	600	300	500	...		600	100	100	...		350	200	250	400	300
	12	600	300	500	...		700	100	100	...		400	200	300	400	350
	13	600	300	500	...		800	100	100	...		400	200	300	500	400
	14	700	300	600	...		900	100	100	...		400	200	400	600	500
	15	800	300	500	...		900	100	100	...		400	200	400	700	600
	16	800	300	500	...		900	100	100	...		400	200	400	700	600
	17	900	300	600	...		900	100	100	...		500	200	400	800	600
	18	900	300	600	...		900	100	100	...		500	200	400	800	600
	19	1000	300	700	...		900	100	100	...		500	200	400	800	600
	20	1000	300	700	...		900	100	100	...		500	200	400	800	600
	21	1000	300	700	...		1000	100	500	...		600	200	500	900	600
	22	1000	300	700	...		1000	100	500	...		600	200	500	900	600
	23	1000	300	700	...		1000	100	500	...		600	200	500	900	600

III. "Incubator Hatches"—Brood No. 3.

February 9, 1898, 250 eggs, all varieties, were placed in the Incubator. Apparently the eggs were in good condition, but were not very uniform in size, nor was it possible to be certain that some had not been chilled. Owing to the fact that this particular machine did not run very regular, at least without very careful watching, the eggs were transferred to another machine. The day on which the eggs were due to hatch I was called by wire to judge poultry at Newbern, N. C., Fair, and was compelled to leave the eggs in the hands of a helper who was not familiar with handling same at this period of the hatch. However, eighty-six strong chicks were taken out. Quite a number more would have hatched, but the operator did not know how to manage.

The infertility of the eggs was due to the following causes:

Too early in the year for strong germs.

Lack of green food.

Old age of a large number of eggs.

The following table shows reading of thermometer in machine three times each day, temperature of the cellar, time when eggs were turned, to what degree the eggs were cooled, and when eggs were tested, giving number which were infertile, and number dead in shell. No moisture was used during the hatch. The first test showed fifty eggs absolutely infertile, and thirty in which the germs had died. The second and last test on February 27, showed fifty-eight dead in shell, leaving 112 eggs containing well developed chicks. On examining the infertile and dead eggs, found that they were all eggs that had been laid in latter part of December and early part of January. Age or a possible chill was the prime cause of their worthlessness. The total cost of feed, average cost per chick, average cost per pound is also given.

Brood No. 3.—Eggs Placed in Machine at 11 o'clock a. m., February 9.

Date.	Cellar Temperature. 7 A. M.	Noon.	5 P. M.	Incubator Temperature. 7 A. M.	Noon.	5 P. M.	Eggs Turned. A. M.	P. M.	Eggs Cooled. 5 P. M.
Feb. 9	42	44	45	98	99	101	....	.....	....
10	40	44	45	101	101	99	....	.....	....
11	38	41	44	103	106	104	7.00	5.00	....
12	40	43	44	102	104	105	8.00	5.00	85°F
13	41	45	45	101	103	103	8.00	5.00	85
14	36	41	42	100	103	104	9.00	5.00	85
15	37	42	42	98	103	103	Did not	turn n	or cool.
16	40	45	48	99½	104	105	8.00	5.00	85
17	32	39	44	98	103	103	8.30	5.00	85
18	28	33	42	97	103	104½	7.30	5.00	85
19	38	40	42	98	104	103	7.00	5.00	85
20	40	44	42	100	104	102	7.30	5.00	85
21	41	44	42	100	102	106	9.30	5.00	85
22	41	45	42	100	103	106	9.30	5.00	85
23	42	50	52	102	103	102	7.30	5 00	85
24	42	50	53	102	104	103	7.00	5.00	85
25	43	48	54	100	104	103	7.00	5 00	85
26	43	48	45	98	104	104	7.30	5.00	85
27	40	48	48	108	104	103	Did not	turn n	or cool.
28	40	47	51	103	103	104	7.00	.....	....
March 1	42	48	52	103	104	105	....	.....	....
2	......	......	....	105	107	105	....	......	....

Eggs tested February 15—Number infertile, 50; dead in shell, 30.
Eggs tested February 27—Number dead in shell, 58.

Cost of Feed.	lbs.	cts.	cents.
Cracked wheat	16.25	1½	24.37
Screanings	85.39	1⅛	96.06
Whole wheat.......	9.18	1½	13.77
Cracked corn.......	96.18	⅞	84 86
Corn meal	54.35	1	54.35
Wheat bran........	41.23	9–10	37.08
Cut bone...........	56.63	1	56.63
Crushed oats.......	6.77	1½	10.16
Cabbage	10.	1	10.
			$3.87.28

Total Cost.	
Value of eggs set..............	$2.50
Oil for incubator and brooder..	1.00
Food...........................	3.87.28
Total..........................	$7.37.28
Total weight of 73 chicks at 8 weeks	109 lbs.
Average cost of each	10.09 cts.
" " per pound.......	6.96 cts.
" weight...............	1.49 lbs.

Brood No. 4.

Two hundred eggs were put in an incubator on evening of February 22, 1898. They were laid by various breeds, and were in good condition and fresh. March 1st, eggs were tested; found 20 infertile, and a few doubtful, which were placed back in machine. The temperature varied somewhat, but not enough to injure the germs to any great extent.

March 11, tested again, and removed five infertile and 18 dead in shell. Morning of March 16, removed to brooder 130 strong chicks; in the evening, 5 more, leaving six very weak. Three of them were killed at once and three more on the evening of the 18th, leaving as a net result, 135 chicks. Machine ran as regular as could be expected in a cellar where the temperature varied from 37 degrees to 63 degrees. No moisture was used. Lack of green food, and apparent indisposition of cocks in yards, 1.7.11., caused, the infertility of the eggs. However, the hatch was satisfactory as to numbers and strength. There were no cripples in the entire 135 chicks transferred to brooder.

The amount of feed given represents	$ 7.57
Value of eggs set	2.00
" oil for incubators and brooders	1.50
Total	$11.07
The 126 chicks weighed, at eight weeks of age	187½ lbs.
Average cost each	9.58 cents
" " per lb	6.42 "
" weight each	1.49 lbs.

Their first feed was cracked wheat, followed by bread made by mixing two parts corn meal, one part wheat bran, then a small amount of cut bone. As they grew stronger, the amounts were increased, substituting whole wheat or screenings for cracked wheat, and gave also one feed daily of finely-cracked corn. Cabbage chopped fine was given on rainy days when it was not advisable to turn them out. On bright, dry days they were allowed to run at large, where they had access to a field of crimson clover. No sickness appeared among them after the seventh day. The broods consisted of various breeds, viz.: Brown Leghorns, Black Minorcas, White Wyandottes, Langshans, Barred Plymouth Rocks, Buff Cochins, Indian Games (White and Cornish). Out of the nine that died, five were white Indian Games. The brooder heat was run about as follows: Thermometer placed on the floor near centre: First week, 95 degrees; second week, 90 degrees; third week, 85 degrees. From that time on to end of sixth week the heat was near 80 degrees.

Fresh water was supplied three times daily, and grit was before them at all times, as well as a fresh bone, with a small amount of lean beef thereon.

One Langshan and one Leghorn pullet began laying early in August. These two pullets outgrew all others, and, strange to say, they were at all times together, never mingling with their mates when turned out each day. We might add that the brooder used was a simple home-made hot water, top heat affair, costing outside of labor and including lamp, about $3.

The following table shows cellar and incubator temperature three times daily during the entire hatch, hours when eggs were turned, and to what degree they were cooled, showing dates when tested, etc.:

Brood No. 4.—Eggs Set at 5. p. m., February 22.

Date.	Cellar Temperature.			Incubator Temperature.			Eggs Turned.		Eggs Cooled.
	7. A. M.	Noon.	5 P. M.	7 A. M.	Noon	5 P. M.	A. M.	P. M.	5 P. M.
Feb. 22	41	45	42	99	103	103	....	......	....
23	42	50	52	100	102	103	....	......	....
24	42	50	53	106	103	103	....	......	85 °F
25	43	48	54	103	106	104	7.00	5.00	85
26	43	48	45	103	106	104	7.00	5.00	85
27	40	48	48	107	103	104	7.00	5.00	85
28	40	47	50	97½	103	99	8.00	5.00	85
March 1	41	48	51	98	103	101	7.00	5.00	....
2	37	43	50	99	102	103	7.00	5.00	80
3	39	44	52	101	104	104	7.00	5.00	80
4	40	47	52	101	105	103	7.00	5.00	80
5	41	49	51	103	103	103	7.00	5.00	80
6	42	49	53	103	103	104	7.00	5.00	80
7	41	48	49	102½	103	103½	7.00	5.00	80
8	40	48	53	103	103	104	8.00	4.30	75
9	43	49	52	103½	104	104	8.00	5.00	75
10	48	52	56	104	103	104	8.00	5.00	75
11	53	58	59	103	105	104	....	......	....
12	53	58	63	101	104	105	8.00	5.00	75
13	55	59	61	102	104	107	8.00	5.00	75
14	55	60	60	101	104	104	....	......	....
15	56	60	61	100	106	104	....	....	....

Eggs tested March 1—Number infertile, 20; dead in shell, 0.
Eggs tested March 11—Number infertile, 5; dead in shell, 18.

Brood No. 5.

March 8, 1898, 5. p. m., placed 200 eggs. They were selected as to size, shape and age, therefore expected the best hatch of the year. The first test (March 15) found 65 eggs infertile and three chicks dead in shells.

About this time I detected a foul odor coming from inside the egg-chamber, and after a very careful examination, failed to ascertain the cause. After the hatch was off, I found in a ventilating tube, a dead mouse.

The tabulated report shows that the temperature of the egg-chamber was excellent, that the eggs were turned regularly, hence the cause of the poor result may have been the interference with ventilation and the odors arising from the mouse. It is very important that not only is the air pure inside the machine, but that the cellar or incubator room is so ventilated that no odors are there. The infertility of the eggs (91 out fo 200) was due to a lack of green food and possibly a lack of sufficient exercise. During the hatch I was absent one and one-half days, and it is possible that during that time the heat may have varied enough to damage the germs, though the attendant's figures showed a proper temperature. In any case, only sixty-five hatched, one being a cripple. These records will give the beginner an idea as to the variations he may expect in artificial incubation. Yet, there is no question but that hatching and rearing artificially is far more satisfactory, both physically and financially, than using hens. No moisture was used, the air-cell forming very well, by the use of ventilators on machine.

BROOD NO. 5.—EGGS PLACED IN MACHINE MARCH 8, 5 P. M.

DATE.	INCUBATOR TEMPERATURE.			EGGS TURNED.		EGGS COOLED.
March.	7 A. M.	Noon.	5 P. M.	A. M.	P. M.	5 P. M.
8	....	....	103	......	......	....
9	103	103½	103½	......	......	....
10	103	103	103½	......	5	85 °F
11	103	103½	103	8	5	80
12	103	103	103	8	5	80
13	103	103½	104	8	5	80
14	102½	103	103½	8	5	80
15	103½	102	102½	......	......	....
16	103	104	103	8	5	75
17	102	103	103½	8	5	75
18	103	103	103	8	5	75
19	103	104	104	8	5	75
20	103	104	104	8	5	75
21	104	103	103	8	5	85
22	103	105	104	......	......	....
23	104	106	103	8	5	85
24	105	103	103	8	5	85
25	103	104	103	8	5	80
26	104	103	103	8	5	75
27	104	103	104	......	......	....
28	103	103	104	......	......	....
29	103	103	103	......	......	....

Eggs tested March 15—No. infertiie, 65; dead in shell, 3.
Eggs tested March 22--No. infertlle, 26; dead in shell, o.

For the benefit of those who desire to keep a condensed monthly report of the poultry yard, we append the form as used by the Experiment Station, with a few additions, which makes it really more desirable.

One can tell at a glance how many fowls and chicks and eggs of each variety there are on hand the first of every month;

The number that died, or were sold;

Number of eggs laid by each yard;

Number of eggs sold for hatching or for table use or set from each yard. Also a blank space for cash and credit sales, and purchases, together with enough space to make any remarks that might be advisable or necessary.

Report of Poultry Section for Month Ending ...., 189...

Breeds.	S. C. Brown Leghorns.	Black Minorcas.	Cornish Indian Games.	Black Langshans.	S. C. Brown Leghorns.	Black Minorcas.	Barred Plymouth Rocks.	Barred Plymouth Rocks.	Buff Cochins.	White Wyandottes.	Light Brahmas.	Pekin Ducks.	Black Langshans.	Black Langshans.	Light Brahmas.	White Indian Games.	Cornish Indian Games.	Miscellaneous Fowls.
No. of fowls mated in each yard Jan. 1 (Total No. mated Jan. 1, 245.)	22	11	9	9	11	11	9	9	9	9	9	22	9	9	9	9	9	60
Number of yard	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number at last report—Fowls, 245	35	30	20	40	See No. 1	See No. 2	30	See No. 7	10	20	28	22	See No. 4	See No. 4	See No. 11	10	See No. 3	See Nos. 1 to 18
Chicks, 100	20		10				20			30		20						
Number sold—Fowls, 15	2	1		2			3		3	1		1				2		
Chicks, 10	5		5															
Number died—Fowls																		
Chicks																		
Eggs laid—2,400	200	100	50	100	150	150	100	100	100	250	100	200	175	160	140	150	175	
Eggs sold—For hatching, 1,058	50	50	26	75	100	40	39	54	90	84	60	50	40	80	80	90	50	
For table use, 552	24	48	24	16	36	80	36	36	6	54	24	24	24	24	24	36	36	
Eggs set—106	56											30	20					
On hand (totals)—Fowls, 230	33	29	20	38	See No. 1	See No. 2	27	See No. 7	7	19	28	21	See No. 4	See No. 4	See No. 11	8	See No. 3	See Nos. 1 to 18
Chicks, 80	15		5				20			30		20						
Eggs, 684	70	2		9	14	30	25	10	4	112	16	96	91	56	36	24	89	

Cash sales	$65 00
Credit sales	65 00
	$ 130 00

REMARKS.—Stock sales fairly good. Health of all fowls excellent. Egg production good. Egg sales, both for hatching and table use, are improving each month.

EXPENSES.

Date.	
1,000 lbs. meal	$10 50
500 lbs. bran	5 00
5 bushels wheat, 90c	4 50
10 bushels corn, 50c	5 00
Labor for month	35 00
	$70 00

RECENT BULLETINS.

The following are some of the recent Bulletins of the Experiment Station:

No. 70. Weed Pests of the Farm; Japan clover, cuts 11, pp. 28.
No. 71. Co-operative Field Tests During 1889; Hill-side Ditches, cut 1, pp. 32.
No. 72. Work in Horticulture; Pea-vine Manuring, pp. 16.
No. 73. The best Agricultural Grasses; plates 74, pp. 100.
No. 75. Fertilizer Analyses; season of 1891, pp. 16.
No. 77. Value of Pea-vine Manuring for Wheat, plate 1, pp. 8.
No. 78. Some Injurious Insects, plates 37, pp. 32.
No. 79. Facts for Farmers, in Plain Language for Farmers' Reading, pp. 24.
No. 80. Silos and Ensilage, pp. 17.
No. 81. Feeding Cotton-seed Hulls and Meal for the Production of Beef, pp. 28.
No. 82. Fertilizer analyses and the Fertilizer Control for 1891, pp. 20.
No. 83. Growing Celery in the South; Cultivation of Onions; Notes of Horticultural Work During 1891, cuts 2, pp. 20.
No. 84. Some Enemies of Truck and Garden Crops, cuts 32, pp. 26.
No. 85. The Late Crop of Irish Potatoes in the South, pp. 10.
No. 86. Tobacco Curing by the Leaf Cure on Wire, and the Stalk Processes, pp. 32.
No. 87. All Publications of the Station, from March, 1877, to September, 1892, pp. 20.
No. 88. Fertilizer Analyses and the Fertilizer Control During 1892, pp. 24.
No. 89. Co-operative Field Tests During 1891 and 1892, pp. 48.
No. 90. Practical Stock Feeding, pp. 32.
No. 91. Some Experiments in Wheat Culture, pp. 20.
No. 93. Feeding Experiments, pp. 48.
No. 94. Horticultural Tests and Results with Vegetables, Fruits and Bulb Culture, pp. 20.
No. 95. The Fertilizer Control During 1893, pp. 32.
No. 96. Miscelleaneous Agricultural Topics, Cuts 19, pp. 32.
No. 97. Digestion Experiments, Fig. 1. pp. 48.
No. 98. Some Leguminous Crops and Their Economic Value, cuts 9, pp. 40.
No. 99. Thread Worm of Pork (Trichina Spiralis), cuts 9, pp. 8.
No. 100. Our Common Insects, cuts 65, pp. 36.
No. 101. The Progress of the Dairy Industry in North Carolina, pp. 8.
No. 102. Encouragement to the Dairy Industry, pp. 12.
No. 103. Miscelleaneous Agricultural Topics, pp. 24.
No. 104. Why Pull Your Corn Fodder? pp. 4.
No. 105. The Chestnut and its Weevil: Nut Culture, pp. 12.
No. 106. Rational Stock Feeding. pp. 44.
No. 107. Prop·gation of Flowering Bulbs in North Carolina, plates 24, pp. 24.
No. 108. Seed Testing; Its Uses and Methods, pp. 64.
No. 109. Feeding Trials With Animals, pp. 34.
No. 110. Marls and Phosphates of North Carolina, pp. 50.
No. 111. The Fertilizer Control During 1894, pp. 26.
No. 112. Trucking in the South, pp. 70.
No. 113. The Testing of Milk, cuts 4, pp. 32.
No. 114. Tests of Dairy Implements and Practices, cuts 4, pp. 32.
No. 115. Miscelleaneous Agricultural Topics, pp. 20.
No. 116. Milk Records and Tests, pp. 16.
No. 117. Tuberculosis and Its Prevention, pp. 20.
No. 118. Cotton Seed Hulls for Beef Production, 4 pages.
No. 119. Volumetic Estimation of Phosphoric Acid, 21 pages.
No. 120. Cultivation of the Peach Tree, 42 cuts, 31 pages.
No. 121. Hillside Terraces or Ditches, 8 cuts, 5 pages.
No. 122. Types of Tobacco and their Analyses. (Technical.) 35 pages.
No. 123. Miscellaneous Agricultural Topics, 10 pages.

No. 125. Forage Grasses and Hay Making, 44 cuts, 49 pages,
No. 126. Why not Improve your Poultry? 5 pages.
No. 128. Pests of Grain Crops, pp. —
No. 129. Horticultural Experiments at Southern Pines, 1895, pp. 46.
No. 130. Poultry Keeping for Profit, 39 cuts, 53 pages.
No. 131. Parasites of Poultry, 13 cuts, 11 pages.
No. 132. The Home Vegetable Garden and its Pests, 8 cuts, 54 pages.
No. 133. Some New Forage Fibre and Other Useful Plants, 2 pages.
No. 136. Fertilizer Analyses of the Fertilizer Control, 34 pages.
No. 137. A warning in Regard to Compost Peddlers, 8 pages.
No. 138. San Jose Scale in N. C., 1 cut, 14 pages.
No. 139. Home-mixed Fertilizers and Composts, 16 pages.
No. 140. Volumetric Estimation of Phosphoric Acid, (Technical) 8 pages.
No. 141. A New Tobacco Pest, 2 cuts, 8 pages.
No. 142. Comfortable Low Cost Barns, 12 cuts, 20 pages.
No. 143. Feeding Experiments, Milk Records, etc., pp. 36.
No. 144. Ornithology of North Carolina, pp. 36
No. 145. Crimson Clover, pp. 20.
No. 146. Miscellaneous Farm Bulletin, pp. 16.
No. 147. A Study of Lettuces, pp. 8.
No. 148. Digestion Experiments, pp. 32.
No. 149. The Apple in North Carolina, pp. 22.
No. 150. Medicinal Plants of North Carolina, pp. 84.
No. 151. The Fertilizer Control for 1897, pp. 12.
No. 152. Poultry Notes, pp. 24.

Any of the above will be sent cheerfully upon application by Postal Card to the Director of the N. C. Agricultural Experiment Station, Raleigh, N. C.

BULLETIN NO. 153 DECEMBER 8, 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

VINEGAR ADULTERATION

AND THE EXTENT TO WHICH IT EXISTS IN THE SAMPLES FOR SALE IN NORTH CAROLINA.

W. A. WITHERS AND J. A. BIZZELL.

RALEIGH, N. C

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M............Professor of Chemistry.
F. E. EMERY, M. S............Professor of Agriculture.
W. F. MASSEY, C. E............Professor of Horticulture
COOPER CURTICE, D. V. S., M. D............Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS., A. M, Acting Director and Chemist.

F. E. EMERY, M. S............Agriculturist.
W. F. MASSEY, C. E............Horticulturist.
COOPER CURTICE, D. V. S., M. D............Veterinarian.
A. W. BLAIR, A. M............State Chemist.
C. B. WILLIAMS, M. S............Assistant Chemist.
H. K. MILLER, M. S............Assistant Chemist.
C. D. HARRIS, B. S............Assistant Chemist.
J. A. BIZZELL, B. S............Assistant Chemist.
F. G. KELLY............Assistant Chemist.
W. G. HAYWOOD, B. LITT............Assistant Chemist.
ALEX. RHODES............Assistant Horticulturist.
C. W HYAMS............Assistant Botanist.
J. M. JOHNSON, M. S............Assistant Agriculturist.
B. S. SKINNER............Superintendent of Farm.
J. M. FIX............Secretary.
H. E. KING............Chief Clerk.
C. M. HUGHES, B. E............Clerk.
MISS M. S. BIRDSONG............Stenographer.
MRS. L. V. DARBY............Stenographer.

The Director's office is in the main building of the College. Telephone No 135 C. The street cars pass within one hundred yards of the College building. The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

VINEGAR ADULTERATION AND THE EXTENT TO WHICH IT EXISTS IN NORTH CAROLINA.

W. A. WITHERS, A. M., CHEMIST.
J. A. BIZZELL, B. S., ASSISTANT CHEMIST.

Commercial vinegar is essentially a dilute aqueous solution of acetic acid. It contains small quantities of alcohol, aldehyde, acetic ether and various extractive matters, which import a characteristic flavor and aroma.

The quantity of acetic acid in vinegar varies from 3 per cent. to 8 per cent., depending upon its source. This acid is produced by the fermentation of alcohol, the change usually being spoken of as *acetic fermentation* in distinction from *alcoholic fermentation* which it frequently follows. Acetic fermentation chemically is essentially oxidation. The transformation in some cases, is spontaneous, while in others artificial methods are necessary. Under the following conditions acetic fermentation sets in :* (1) a liquid weak in alcohol, containing not more than 12 per cent., (2) abundant access of air, (3) a temperature of from 20 ° to 30 ° C. (68 ° to 95 ° F.,) (4) acetic ferments. These ferments consist of peculiar microscopic plants, the most common of which is technically called *Mycoderma aceti.* When these germs fall from the air into suitable liquids they develop under certain conditions a gelatinous mass, which, on increasing in weight, settles to the bottom of the vessel and constitutes what is commonly called "Mother of vinegar."

VARIETIES OF VINEGAR.

The principal varieties are as follows :*

(1) wine vinegar made from grape juice and inferior wines; (2) spirit vinegar, from potato brandy in Germany and from whiskey in the United States; (3) malt vinegar, made from malt wort, similar to that prepared for grain spirit manufacture; (4) cider vinegar, from spontaneous fermentation of apple juice; (5) vinegars of limited use, manufactured from glucose, cane-sugar, sugar-beets and molasses.

The following table shows the composition of the most common varieties of vinegar manufactured and sold in the United States:

---

*Sadtler Hand-book Industrial Organic Chemistry

TABLE I*.

	ACETIC ACID.	TOTAL SOLIDS.	ASH.
Cider	4.46 per cent.	2 83 per cent.	.39 per cent.
Wine	4.54 per cent	2.77 per cent.	.30 per cent.
Malt	4 86 per cent.	2.16 per cent.	.24 per cent.
Spirit.	3.84 per cent.	.38 per cent.	.06 per cent.

ADULTERATION AND FRAUD.

According to Blyth,† the adulterants of vinegar, which have been found and which are employed, to some extent, at present are (1) water, (2) mineral acids, (3) metals—arsenic, copper, lead and zinc, (4) pyroligneous or wood acid, (5) organic coloring matters. The above taken from an English work, represents fairly well the adulterants used to a large extent, in English vinegars. It is satisfactory to note, however, that in a large number of samples of vinegar examined in different parts of the United States deleterious adulterants have seldom been used. The fraud practiced in the United States consists: (1) an addition of water to increase the bulk—a very common method of adulteration as shown by the analyses of the samples examined; (2) in substituting one variety of vinegar in order to increase the sale. A very large portion of vinegar is made in the United States from spirituous liquors. Battershall‡ says, "It is probable that fully 90 per cent. of the total production is obtained by the acetic fermentation of whiskey." The vinegar thus produced is nearly colorless. It is colored, however, with caramel and other organic coloring matter and placed upon the market as apple vinegar. Cider vinegar producers, therefore, have found it impossible to compete with unscrupulous manufacturers, who impose on the public by selling "apple vinegar" made from low-wines.

COLLECTION OF SAMPLES.

The object of our work has been to determine to what extent adulterants are present in the vinegars sold in North Carolina, and to what extent fraud is practiced upon the people of the State. As many different samples as were obtainable were bought from dealers in Raleigh, Durham, Henderson, Statesville and Wilmington. No effort was made to select places in which it might be supposed that adulterated goods would be most abundant. To this end samples were obtained from "fancy groceries" as well as from the cheaper places.

*Jour. Am. Chem. Soc. 20. 6.
†Foods composition and Analyses.
‡Food Adulteration and its Detection.

METHODS OF ANALYSIS.

The methods employed in the examination were those proposed to the Association of Official Agriculturists at its fourteenth annual convention.

RESULTS OF ANALYSIS.

The following table gives the results of the analysis of twenty samples of vinegar:

TABLE II.

Laboratory No.	Analysis. Acetic Acid. Per cent.	Total Solids. Per cent.	Ash. Per cent.	Name given by retailer.	Name of Manufacturer.
1042	4.41	.637	.135	Cider vinegar	H. J. Hinz, Pittsburgh, Pa.
1084	4.65	.359	.052	"	Jos. S. Friedman, Paducah, Ky.
1085	4.41	.415	.083	"	Wallace Bros., Louisville, Ky.
1086	1.75	.570	.108	"	Alden Vinegar Company, Luisville, Ky.
1170	4.18	76	45	"	(Not given.)
1128	4 55	.355	.038	"	Jones Bros., Louisville, Ky.
1129	3.08	.250	.031	"	Jones Bros., Louisvi le, Ky.
1130	4 83	343	033	"	R. M. Hughes, Louisville, Ky.
1131	4.24	3 67	.319	"	J. C. and S. R. Mott.
1132	4 42	.262	.018	"	J. C. and S. R Mott.
1133	4.98	.228	.018	Grape vinegar	H. J. Hinz, Pittsburgh, Pa.
1134	3.73	.800	.150	Cider vinegar	Gregory Bros., Richmond, Va.
1135	4.21	.336	.064	"	Greg ry Bros , Richmond, Va.
1136	4.17	.461	.079	"	Price Lucas. Louisvi le, Ky.
1137	3 98	.404	.083	"	Louisville Cider Works, Louisville, Ky.
1196	4.38	65	.38		William Munson, Baltimore, Md.
1265	4.55	71	.087		(Not given.)
r259	1.57	.655	.021		Piedmont Cider and Vinegar Works, Lynchburg, Va.
1266	4.56	.34	047		(Not given.)
1267	4.51	.34	.052		(Not given.)

CONCLUSIONS.

The above table represents the analyses of twenty samples of vinegar, fourteen of which were sold for pure cider vinegar, five presumably sold for cider vinegar though this was not stated, and one sample sold for grape vinegar. Of the twenty samples of vinegar thirteen compare favorably with cider vinegar so far as the amount of acetic acid is concerned, while five samples were decidedly too weak in acidity. The amount of total solids and ash indicates only one sample of pure cider vinegar. When we consider that the addition of water reduces the proportion of total solids as

well as of acetic acid, two samples indicate diluted cider vinegar. The remaining seventeen samples indicate spirit vinegar with the addition of organic coloring matter to give the nut brown color. The so-called grape vinegar is the spirit vinegar without the artificial coloring.

Our investigations show, therefore, that ninety-five per cent. of the samples of vinegar examined by us are not pure cider vinegar. The adulterants found present by us are not injurious to health, but their presence is for the purpose of deception and therefore fraudulent. Such a practice should be condemned by law.

In the United States the best known and most esteemed vinegar is that obtained in the acetic fermentation of apple cider, but by far the largest quantity is made from alcohol and spirituous liquors.

In view of the large number of analysis made in various parts of the United States and the laws enacted by many States, the following requirements seem to us not to be at all unjust:

(1) That all vinegars shall contain not less than four per cent. by weight of absolute acetic acid, and must contain no lead, copper, mineral acids or artificial coloring matter.

(2) That all vinegars must be branded with the name of the fruit or substance from which it is made, together with the name and address of the manufacturer.

(3) Cider vinegar shall not contain less than 1¾ per cent. by weight of cider vinegar solids.

CHAPTER 122, PUBLIC LAWS 1895.

AN ACT TO PREVENT THE ADULTERATION, MISBRANDING AND SALE OF FOODS.

The General Assembly of North Carolina do enact:

SECTION 1. That the introduction into the state of any article of food which is adulterated or unbranded, within the meaning of this act, is hereby prohibited; and any person who shall knowingly violate any provisions of this act shall be guilty of a misdemeanor, and for such offence shall be fined not exceeding two hundred dollars for the first offence, and for each subsequent offence not exceeding three hundred dollars, or be imprisoned not exceeding one year, or both, in the discretion of the court.

SEC. 2. The term "food," as used herein, shall include all articles used for food or drink by man, whether simple, mixed or compound. The term "misbranded," as herein used, shall include all articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement purporting to name ingredients or substances as being contained or not being contained in such article, which statement shall be false in any particular.

SEC. 3. That for the purpose of this act an article shall be deemed to be adulterated in case of food or drink, first: If any substance, or substances, has or have been mixed and packed with it so as to reduce, or lower, or injuriously affect, its quality or strength, so that such product, when offered for sale, shall be calculated and shall tend to deceive the purchaser; second, if any infer or substance or substances, has or have been substituted, wholly or in part, for the article, so that the product, when sold, shall tend to deceive the purchaser; third, if any valuable constituent of the article has been, wholly or in part, abstracted, so that the product, when sold, shall tend to deceive the purchaser; fourth, if it be an imitation of, or sold under, the specific name, brand or trade-mark of another article; fifth, if it be mixed, colored, powdered or stained in a manner, whereby damage is concealed, so that such product, when sold, shall tend to deceive the purchaser; sixth, if it contain any added poisonous ingredient, or any ingredient which may render such article injurious to the health of the person consuming it; seventh, if it consists of the whole, or any part, of a discarded, filthy, decomposed or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal which has died otherwise than by slaughter: *Provided*, that an article of food which does not contain any added poisonous ingredient shall not be deemed adulterated or misbranded, in the following cases: First, in the case of mixtures or compounds, which may be now or from time to time hereafter, known as articles of food under their own distinctive names, and not included in definition fourth of this section; second, in the case of articles labeled, branded or tagged so as to plainly indicate that they are mixtures, compounds, combinations or blends; third, when any matter or ingredient has been added to the food because the same is required for the production or preparation thereof as an article of commerce in a state fitter for carriage or consumption and not fraudulently increase the bulk, weight or measure of the food or conceal the inferior quality thereof; *Provided* that the same shall be labled, branded or tagged so as to show them to be compounds: *And, provided further*, that nothing in this act shall be construed as requiring or compelling manufacturers of articles of food to disclose their trade formulas; fourth, when the food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

SEC. 4. That this act shall not be construed to interfere with commerce, or any inter-state commerce laws, of the United States.

SEC. 5. That any article of food that is adulterated or misbranded, within the meaning of this act, or is transported or being transported into the State for sale, and is still in the original or unbroken packages, shall be liable to be proceeded against in any court of this state, within the district where the same is found, and seized for confiscation by a process of libel for condemnation. And if such article is condemned as being adulterated or misbranded, the same shall be disposed of as the said court may direct, and the proceeds thereof, if sold, less the legal costs and

charges, shall be paid into the treasury of the state. The proceedings in such libel cases shall conform, as near as may be, to proceedings in admiralty, except that either party may demand trial by jury on any issue of fact joined in such case, and all such proceedings shall be at the suit of and in the name of the state of North Carolina.

SEC. 6. That this act shall be in force from and after its ratification.

Ratified the 2nd day of March, A. D. 1895.

BULLETIN NO 154 DECEMBER 17, 1898

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

THE ADULTERATION OF COFFEE AND TEA

OFFERED FOR SALE IN NORTH CAROLINA.

W. A. WITHERS AND G. S. FRAPS.

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

BOARD OF TRUSTEES.

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M.............................Professor of Chemistry.
F. E. EMERY, M. S.............................Professor of Agriculture.
W. F. MASSEY, C. E.............................Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D..................Professor of Veterinary Science

EXPERIMENT STATION STAFF.

W. A. WITHERS., A. M, Acting Director and Chemist.

F. E. EMERY, M. S.......................................Agriculturist.
W. F. MASSEY, C. E.......................................Horticulturist.
COOPER CURTICE, D. V. S., M. D..........................Veterinarian.
A. W. BLAIR, A. M.......................................State Chemist.
C. B. WILLIAMS, M. S.......................................Assistant Chemist.
H. K. MILLER, M. S.......................................Assistant Chemist.
C. D. HARRIS, B. S.......................................Assistant Chemist.
J. A. BIZZELL, B. S.......................................Assistant Chemist.
F. G. KELLY.......................................Assistant Chemist.
W. G. HAYWOOD, B. LITT.......................................Assistant Chemist.
ALEX. RHODES.......................................Assistant Horticulturist.
C. W. HYAMS.......................................Assistant Botanist.
J. M. JOHNSON, M. S.......................................Assistant Agriculturist.
B. S. SKINNER.......................................Farm Superintendent.
J. M. FIX.......................................Secretary.
H. E. KING.......................................Chief Clerk.
C. M. HUGHES, B. E.......................................Clerk.
MISS M. S. BIRDSONG.......................................Stenographer
MRS. L. V. DARBY.......................................Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

THE ADULTERATION OF COFFEE AND TEA.

W. A. WITHERS, A. M., CHEMIST.

G. S. FRAPS. B. S., ASSISTANT CHEMIST.

The General Assembly of North Carolina enacted, in 1895, a law which made the adulteration or misbranding of articles of food a misdemeanor, but no one was charged with the duty of executing the law. The present bulletin is one of a series of investigations, undertaken by the Station, to ascertain the extent to which adulteration is practiced on some of the most common articles of food sold in the State. It is necessary to give first a brief account of the methods which have been employed for the adulteration of coffee and tea, and the manner in which the adulterations are detected, before going on to the results obtained in the examination of the samples.

ADULTERATION DEFINED.

A clear and unambiguous definition of adulteration is needed before beginning the study of the subject. One must know exactly what constitutes an adulteration before he can say "this article is adulterated." An excellent definition is found in the act of the General Assembly alluded to above:

The term "food," as used herein, shall include all articles used for food or drink by man, whether simple, mixed, or compound. The term "misbranded," as herein used, shall include all articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement purporting to name ingredients or substances as being contained, or not being contained, in such article, which statement shall be false in any particular.

An article shall be deemed to be adulterated in the case of food or drink:

(1) If any substance or substances has, or have been, mixed or packed with it so as to reduce, or lower, or injuriously affect its quality or strength, (so that such product, when offered for sale, shall be calculated and shall tend to deceive the purchaser.)

(2) If any inferior substance or substances has, or have been substituted wholly, or in part, for the article.

(3) If any valuable constituent has been wholly, or in part, abstracted.

(4) If it be an imitation of, or sold under, the specific name, brand or trade mark of another article.

(5) If it be mixed, colored, powdered or stained, in a manner whereby damage is concealed.

(6) If it contain any added poisonous ingredient, or any ingredient which may render such article injurious to the health of the person consuming it.

(7) If it consists of the whole, or any part, of a discarded, filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, which has died otherwise than by slaughter.

Provided, That an article of food which does not contain any added poisonous ingredient shall not be deemed adulterated or misbranded in the following cases:

(1) In the case of mixtures or compounds, which may be now, or from time to time hereafter, known as articles of food under their own distinctive names, and not included in definition fourth of this section.

(2) In the case of articles labeled, branded, or tagged, so as to plainly indicate that they are mixtures, compounds, combinations or blends.

(3) When any matter or ingredient has been added to the food because the same is required for the production or preparation thereof, as an article of commerce in a state fitter for carriage or consumption, and not fraudulently increase the bulk, weight or measure of the food, or conceal the inferior quality thereof. *Provided*, that the same shall be labeled, branded, or tagged, so as to show them to be compounds; *and provided*, *further*, that nothing in this act shall be construed as requiring or compelling manufacturers of articles of food to disclose their trade formulas.

(4) When the food is unavoidly mixed with some extraneous matter in the process of collection or preparation.

The fifth definition of adulteration given, is defective. In the New York State Law, it reads: If it be colored or coated or polished, whereby damage is concealed, or it is made to appear better than it really is, or of greater value.

ACKNOWLEDGMENT.

Free use was made of the following works in the preparation of this bulletin: Hassall's, Blyth's and Battershall's works on food adulteration; James' Bell's Chemistry of Foods; and Bulletin No. 13, U. S. Department of Agriculture, Division of Chemistry, on Foods and Food Adulteration. The last named publication, prepared under the direction of Dr. H. W. Wiley, deserves special mention and acknowledgment.

COFFEE.

The coffee tree is a shrub-like plant, cultivated in various tropical countries. The tree bears a fruit resembling a small cherry, with two seeds or coffee grains embedded in the pulp. The fruit is dried, and the seeds removed from the outer covering. Coffee, as imported, contains a certain amount of broken grains, immature and light grains, portions of the outer covering, sticks and other foreign matter. These are removed by screens—sifted, as it were—and by a blast of air, which carries away the lighter materials. The amount of such material left in the coffee would depend on the thoroughness of the purification.

Coffee moderately excites the circulatory system and stimulates the digestive function. It gives rise to increased vigor of imagination and intellect, without any subsequent confusion or stupor, and another of its effects is a disposition to wakefulness. But taken in large quantities, it leaves, after its first effects, a degree of nervous derangement or depression, equivalent to the previous excitement. Its habitual immoderate employment is well known very greatly to injure the tone of the stomach, and frequently to occasion troublesome nervous and dyspeptic affections.*

The properties of coffee are mainly due to three substances, an essential oil, caffeo–tannic acid, and caffeine. Caffeine has a decided action on the animal organism, and coffee probably owes much of its value to its presence ; the similar effects of coffee and tea have their source in the possession of caffeine by tea also. The percentage of caffeine in coffee varies from about 0.6 % to 2.2 %. It has about 11 % of coffeo-tannic acid, and and the quantity of essential oil is very small. Raw or green coffee contains about 11 % moisture, coffee roasted, 1.2 % moisture.

THE ADULTERATION OF COFFEE.

According to the definition of adulteration already given, coffee may be considered as adulterated ; if foreign matter of any kind has been added to reduce the strength or affect the quality ; if cheaper substances have been substituted in part, or wholly, for the coffee ; if the coffee has been colored to imitate better grades or to conceal damage.

It is purposed to give here a short account of the methods which have been used to adulterate coffee, and the manner in which these adulterations may be detected. Ground coffee is tampered with much more than whole coffee, as the condition of the mixture makes such operations less easily detected than with whole coffee.

*U. S. Dispensatory.

Facing.—The coloring of coffee, to imitate better grades, or otherwise improve the commercial value, is called facing. Some of the pigments used are Prussian blue, indigo, lead chromate, clay, azo colors, and charcoal. The raw berry is moistened with water containing a little gum and agitated with the coloring mixture. The coloring matter used forms only a very small percentage of the coffee; and while the pigments might be harmful if consumed in appreciable quantity, one would have to drink a large amount of coffee to take even the smallest medicinial dose. There is no evidence that the coloring matter is injurious to the health, but injurious or not, its presence is an adulteration.

Detection.—To detect facing, the coffee is shaken with water, and the sediment examined microscopically or chemically. With the microscope, greenish blue particles show the presence of indigo; brilliant blue particles, Prussian blue. Azo colors are dissolved by soaking the coffee in alcohol; the aqueous solution obtained from this will give the characteristic reactions. Lead chromate is detected in the ash by the usual qualitative tests for lead and chromium. Facing is usually confined to green coffees.

Glazing.—Coffees are often roasted with the addition of sugar or syrup. This is called glazing. Some coffee roasters claim that it is necessary to glaze the coffee to prevent the loss of its aroma, or the absorption of qualities that are injurious to it. Experiments have shown that coffee roasted with sugar weighs from four to twelve per cent. more than the same coffee roasted without sugar. This gain in weight is a decided advantage to the roaster, and as decided a disadvantage to the consumer. The increase in weight is due partly to the roasted sugar and partly to the water, which is retained to a greater extent by the glazed than by the unglazed berry. Excessive glazing gives the berry a glossy black appearance, and the dark brown substance formed by roasting sugar colors the coffee infusion and makes it appear stronger than it really is. Moderate glazing need not be considered an adulteration if the fact is stated on the label; excessive glazing must be considered so under any circumstances.

To detect glazing, 20 grams of the whole beans are violently shaken with 500 cc destilled water for five minutes, diluted to 1,000 cc, 50 cc of the filtered liquid evaporated, dried, weighed, ignited and the ash deducted. Pure roasted coffee shows from 0.44 to 0.72 per cent. soluble organic matter, while coffee roasted with sugar gives from 1.81 to 8.18 per cent., according to Stutzer and Reitnair. With this work as a basis, it would be fair to assume that coffee, giving an organic extract greater than 1 % has been glazed, while if more than 2 % it is excessively glazed. Further investigation may change these limits; they allow a liberal latitude for variation in coffees, and are based upon experimental work.

Coffee Screenings.—As already stated, coffee, as imported, contains immature and light grains, broken grains, and foreign matter, and these are usually removed as screenings. Coffee screenings largely consist of fragments of pure coffee beans, yet, if sold as coffee, or mixed with coffee, they must be considered as adulterants. One cannot demand that a cheap coffee be carefully purified. It is to be expected that coffee of this kind will contain a certain per cent. of broken grains and immature grains, and also a very small per cent. of the impurities which naturally accompany coffee. Exactly what limits should be set to this allowance, limits which, if exceeded, would condemn the coffee as adulterated, this bulletin cannot undertake to fix. Such limits could be formulated only on the basis of a careful examination of numerous coffees as they are imported, and a study of the process of screening or purification. It is very desirable for those who have to examine foods to possess standards of this kind. Such standards have been adopted for use in the examination of tea and of vinegar, and they are necessary for coffee also, as far as glazing and impurities incidental to the gathering of coffee. In the absence of a standard it may be asserted, in general terms, that the coffee should not contain a high percentage of broken or immature grains, or more than an insignificant quantity of incidental impurities, as sticks, stones, etc.

Detection. Broken coffee and immature coffee may be easily separated from the whole grain. With ground boffee, this is impossible. The presence of coffee screenings in ground coffee may be inferred, if any considerable amount of sand can be separated. In the case of a coarsely ground coffee sometimes the outer hull of the berry can be picked out when the coffee has been adulterated with coffee screenings. The hull has a peculiar coiled, shell-like shape where it joins the stem. Sand and stones can best be separated by pouring the coffee on water, and sorting the sediment.

Imitation Coffee.—Imitation coffees or coffee substitutes are manufactured on a large scale in America, Germany, and England. Of twenty-two imitation coffees, collected by the U. S. Department of Agriculture in 1892, and examined in its laboratory, two were imitation raw coffee beans, eleven imitation roasted coffee beans, and ten were pellets and granule-. They consisted chiefly of wheat flour, bran, and chicory, with occasionally some coffee. The use of imitation coffee, for the genuine article is clearly fraudulent.

Detection. The addition of imitation coffee to ground coffee really amounts to the addition of flour, bran, and chicory, and the method of detecting these substances will be indicated later. Roasted coffee will usually float on water or 40 per cent. alcohol, while imitation coffee sinks. Imitation beans may be detected in whole roasted coffee by the presence of a small particle of parchment-like structure in the cleft of that which sinks, or by the ap-

pearance of its structure. In green coffee, the imitation can be found only by a careful bean-by-bean examination, breaking each one. In either case the tests mentioned above for use with ground coffee may be applied.

Root Adulterants.—Roasted roots of the dandelion, turnip, chicory, etc., have been used as adulterants. The addition of chicory is a common practice. Chicory is the prepared root of the plant Chicorium Intybus, largely cultivated in Europe; the root is used as a substitute for coffee, or to adulterate it. Many coffee drinkers prefer a mixture of coffee and chicory to pure coffee, and such a mixture may be properly sold if its composition is stated on the package, or made known to the purchaser; otherwise the mixture must be condemned as adulterated.

Detection. If ground coffee be sprinkled on water, nearly the whole of it will float, coloring the liquid but slightly; chicory will separate and sink, imparting a brown color to the liquid. A microscopic examination of the particles which sink is necessary, when chicory reveals itself by the peculiar nature, of their structure. A heavily glazed coffee would color the water whether chicory were present or no. Other tests for chicory are known, but need not be mentioned in an article of this kind.

Seeds and Seed Products.—Canna seeds, cassia seeds, ground date stones, leguminous seed, such as peas and beans, and finally the cereals, as wheat, barley, and rye, have all been used, from time to time, as coffee adulterants. In this country, cereals and leguminous seeds are used; the occurrence of the others here is very rare. Like chicory, the cereals and leguminous seeds will sink in water, imparting a decided color. Moistened with water, they become softened, while coffee remains hard.

Detection. Coffee contains no starch, while the great majority of seeds, likely to be mixed with it, as beans, peas, acorns, cereals, all cereal products, imitation coffee—all contain a notable quantity. The absence of starch shows that none of these are present. Starch is easily detected chemically or microscopically. To detect it chemically in coffee, the powdered coffee is boiled with water, cooled perfectly, acidified with dilute sulphuric acid, and a strong solution of potassium permanganate added cautiously, until the coloring matter is nearly destroyed. The filtered liquid gives a blue coloration with a solution of iodine if starch is present. To detect starch microscopically, the finely powdered sample is mounted in Canada balsam and examined with polarized light. Starch shows a dark cross on a white field. If starch is found, the problem is next to determine the nature of the admixture, that is, whether it be peas or beans or wheat or something else. The origin of a starch can be detected by the microscope, as will be shown in the Bulletin on the Adulteration of Flour. Sufficient of the original structures will usually remain, to allow of their com-

plete microscopic identification, so one can tell if flour or bran, peas or pea-hulls, have been used.

EXAMINATION OF SAMPLES BOUGHT ON THE OPEN MARKET.

The object of this investigation, it may be repeated, was to ascertain the extent of adulteration of the coffee for sale in North Carolina, and the nature of the adulterants used. To attain this object, each sample should represent as great a number of pounds of coffee as possible; each should be of wide, rather than local application. Probably all cheap roasted coffees sold in North Carolina are placed on the market in small packages of unground grains, mostly containing a pound. The higher grades usually come in large packages. Most stores possess a coffee-mill, and if the customer desires ground coffee the whole bean is ground before his eyes. While this is, of course, no guarantee that the coffee is not mixed with some adulterant during the process of grinding, this investigation could not concern itself with such individual adulteration of merely local bearing. The samples must be representative of more than a single locality. Such samples are offered by the coffees which come on the market in sealed packages, and by samples of whole roasted coffee as it reaches the dealer. Accordingly, samples of this kind were collected by purchase from all grades of stores, and made the object of an examination.

DESCRIPTION OF SAMPLES.

Laboratory Number.	Brand.	Packer or Roaster.	Price per Pound.	Where Purchased.
1043	Special	Bulk	25	Statesville.
1044	Number Twelve	Not given	10	Statesville.
1045	Ariosa	Arbuckle Bros	13	Statesville.
1046	Levering's	E. Levering & Co	12	Statesville.
1080		Bulk	15	Raleigh.
1081	Lion	Woolson Spice Co	20	"
1082	Aden Mocha	Bulk	18	"
1083	Crescent	Smith Bros	20	"
1138	Red Seal, Number Nine,	Not given	10	"
1139	Hero. Coarse ground	Not given	10	"
1140	Princess	F. Middleton & Co	13	"
1141	Red Seal, Number Ten	Same as 1138	10	"
1142	Crescent	Same as 1083	13	"
1143	Lown's Capital	W. G. Lown	13	"
1144	Mocha and Java Blend	Bulk	25	"
1154		Bulk	12½	Durham.
1155	Arica	Austin, Nichols & Co	12½	"
1156	Crown	Conley, Ach & Conley	25*	"
1157	Star	W. G. Lown	20†	"
1158	Monogram	Charleston Impt. and Expt. Co	35	Raleigh.
1190	Red Owl	" "	12½	Raleigh.
1202	Momaja	American Grocery Co	30	Henderson.

*Crown coffee was 25 cents with cup, saucer, and plate. †Star coffee was in milk can.

The coffees in the table not stated to be in bulk were in packages. Three of them were of unknown origin, and therefore suspicions, as a reliable dealer is always ready and willing to have his name advertised on the package. The name of No. 1044 varies with the locality; in Statesville it was called "Number Twelve," in Raleigh "M and S," and packages were also found in Raleigh which bore no name. This coffee is put up in yellow packages, and a name printed on to suit the retail dealer. No. 1140 (Princess) contained a teaspoon, as stated on the package; No. 1143 (Lown's Capital) contained a stick of candy, weighing ½ oz., and the fact was not stated on the package. The selling of candy, teaspoons, etc., in a sealed package with coffee must needs be condemned as adulteration, unless the fact of such admixture is distinctiy labeled on the package. Such sophistications are ingenious, as the purchaser does not always realize that he is buying the candy, etc., at the price of coffee, and is disposed to consider it as a gift.

Facing.—All the coffees were roasted; there was no reason to examine them for facing, which is confined almost exclusively, to green coffees.

Glazing.—A test was made for glazing, in the manner already described. The percentage of cold water extract found in that way is given in the following table:

1043	0.73	1082	1.09	1155	1.84
1044	2.36	1083	1.81	1156	1.35
1045	1.92	1140	1.39	1157	2.50
1046	1.19	1143	2.20	1158	0.99
1080	2.78	1144	0.82	1190	1.48
1081	1.46	1154	1.15		

On the basis of the limits already laid down, (see Glazing) we must consider coffees giving more than one per cent. organic extract to be glazed, that is, roasted with sugar or other glazing material, and if the coffee shows over two per cent. organic extract, it is to be considered as excessively glazed. All the above samples, except three (1043, 1144 and 1158), must be considered as glazed; four are excessively glazed:

1044, Number Twelve.............. Unknown origin.
1080 .... bulk.
1143, Lown's Capital.................. W. G. Lown.
1157, Star .... W. G. Lown.

The extract was not determined in Red Seal, (1138, 1141) and Hero (1139), on account of their broken condition, but both were probably glazed, a fact recognized by even a casual examination. The method of examination for glazing could not fairly be applied to a broken coffee.

It should be recalled that the result of glazing is an increase in weight of the coffee, and that excessive glazing must always be considered as an adulteration. Moderate glazing is allowable if the fact is labeled on the package; this statement was made on Ariosa (1045) and Crown (1156), some of the coffees asserted absolutely that no glazing material whatever had been used in their preparation.

In the following statements only the coffees are included whose organic extracts are in the table.

Of 17 coffees, 14 were glazed—82%.

Of 17 coffees, 4 were excessively glazed—23.5 %.

Of three coffees costing over twenty cents per pound, all were unglazed.

Of fourteen coffees costing less than twenty cents per pound, all were glazed.

It is curious that while some manufacturers assert that glazing is necessary to the preservation of the coffee, all the high-grade coffees were unglazed, and all the low grade glazed. If glazing is necessary to preserve the good qualities of a poor coffee, how much more necessary ought it to be to preserve the better qualities of a fine coffee.

Coffee Screenings.—The following table includes coffees whose content of broken coffee, or of immature and damaged coffee, is greater than ten per cent, and also those which contain foreign matter, such as sticks, stones, and the outer covering of the coffee berry:

Number.	Brand.	Immature and Damaged Coffee.	Broken Coffee.	Foreign Matter.
		Per cent.	Per cent.	Per cent.
1044	Number Twelve........	25	28.5	....
1046	Levering's............	....	....	0.5
1083	Crescent................	14	23.5	1.4
1138	Red Seal, Number Nine.	13	47.5	5.5
1139	Hero..................	Coarse ground.....	....	7.6
1140	Princess..............	....	....	0.2
1141	Red Seal, Number Ten..	10	42	7.1
1142	Crescent................	Not determined.....	12	0.3
1154	....	....	10	1.0
1155	Arica..................	....	....	1.0
1156	Crown..................	....	13	2.4
1190	Red Owl................	11	....	0.6

The small amount of foreign matter in most of the above coffees was probably due to imperfection in the process of screening, not to any fraudulent admixture. The following coffees, however, must be considered as adulterated with coffee screenings:

1044, Number Twelve, unknown orign.
1138 }
1141 } Red Seal, unknown origin.
1139, Hero, unknown origin.
1083, Crescent, Smith Bros.

Crescent, 1142, was very different in character from Crescent 1083, and the former cannot be considered as adulterated. The foreign matter in Hero was largely composed of the outer hull of the coffee berry and sand. Although the sample was coarsely ground, 7.6 % of this material could be picked out of it, and there is good reason to presume this coffee is composed entirely of coarsely ground coffee screenings. The list above justifies the warning against goods of unknown origin. A dealer is glad to advertise himself on the label of articles of medium or even only good quality. When he refuses to place his name on a package of goods one can suspect something is wrong. Of three coffees examined of unknown origin, three were adulterated.

In 20 coffees, 4 were adulterated with coffee screenings—20 %.

Imitation Coffee.—Tests for imitation coffee were made in every sample examined; no imitation coffee was found. The present low price of coffee probably discourages the manufacture of imitation coffee. Cheap coffee is so cheap that it hardly pays to manufacture coffee to mix with it, and high-grade coffee can be more easily mixed with cheap coffee with less danger of detection. This may account for the absence of the imitation in all the samples examined.

Root adulterants, seeds and seed products, cannot be used to adulterate whole coffee very well. Their sphere of activity is the ground article. They enter into whole coffee in the form of imitation coffee.

SUMMARY.

In 20 coffees, four were adulterated with coffee screenings—20 per cent.

In 17 coffees, 14 were glazed—82 per cent.

In 17 coffees, 4 were excessively glazed—23.5 per cent.

In 20 coffees, 7 were adulturated—35 per cent.

All cheap coffees examined were glazed.

All coffees of unknown origin were adulterated.

No high priced coffees were found adulterated.

STATISTICS OF COFFEE ADULTERATION.

U. S. Department of Agriculture.

18 green coffees, none adulterated.

60 whole roasted coffees, 6 adulterated—10 per cent.

30 ground coffees, 27 adulterated—90 per cent.

In 50 % of the ground coffees, the purchaser obtained only half, or less than half, the coffee he paid for.

Connecticut (*1897*).

26 whole-roasted coffees, 2 adulterated 7.7 %.

45 ground coffees, 39 adulterated 87 %.

Pennsylvania.

120 coffees examined, 16 adulterated 13.3 %.

The following is quoted from the Bulletin of the U. S. Department of Agriculture on Foods and Food Adulterations. "The examination of the coffees and coffee preparations on our markets show that the consumer, and especially the poor, are being grossly deceived. Very little pure ground coffee is sold, and even whole coffee does not escape sophistication. The purchase of green coffee for home roasting does not insure a pure product, since green coffee is imitated. Stringent laws are certainly needed to repress these frauds."

TEA.

The tea plant is a hardy, evergreen shrub, and "tea" is its prepared leaf. The plant is cultivated chiefly in Asia; China provides about 51 % of our tea, Japan 42 %, India 7 %. Black tea and green tea are leaves of the same kind of plant, the character of tea produced depending on the manner in which the leaf is cured. For black tea, the leaves are bruised to liberate the juices, allowed to ferment, and then dried; for green tea, the fresh leaves are steamed, next rolled, and dried as quickly as possible in order to prevent fermentation. The exact details of the preparation of the two kinds of tea vary from farm to farm, and country to country, but the main difference in treatment is as stated above; black tea has been fermented, green tea has not.

Tea is astringent and gently excitant, and, in its finer varieties exerts a decided influence over the nervous system, evinced by the feeling of comfort and even exhileration which it produces, and the unnatural wakefulness to which it gives rise, when taken in unusual quantities, or by those unaccustomed to its use. * * * * Taken moderately, and by healthy individuals, it may be considered as perfectly harmless; but long continued in excessive quantity it is capable of inducing unpleasant nervous and dyspeptic symptoms, the necessary consequences of over-excitement of the brain and stomach.*

The most prominent characteristics of tea are very probably due to the presence of a substance called caffeine in it. A comparison of the properties of tea and coffee, shows that a decided simiiliarity exists between them. The resemblance is easily explained if we recall that caffeine is found in coffee also. Tea contains no caffeo-tonnic acid; the essential oil which gives tea its aroma and

*U. S. Dispensatory.

flavor is quite different from the essential oil in coffee. The percentage of caffeine in tea varies from 1.0 % to 3.4 % (compare coffee); of essential oil, 0.6 % to 1.0 %. The market value of a tea is determined solely by the properties of the infusion it gives, and not by its chemical composition. The professional tea taster examines the quality of its flavor and the body of the infusion, and these factors determine the market value of a tea.

THE ADULTERATION OF TEA.

Here, as under coffee, there is no intention of giving a detailed description of methods of adulterations and their detection. The treatment will be brief, and only in outline.

Facing.—The facing of tea is analogous to the facing of coffee, but it is of much more common occurrence. The leaves are moistened with rice water, warmed, and the finely powdered color shaken on, the mixture being continuously stirred until a uniform tint is produced. The pigments used, alone or in mixture, include Prussian blue, indigo, black lead and turmeric. The amount of coloring matter in faced tea is usually very small although statements have been made that 1 to 3 per cent. has been was found. There is no evidence that the coloring matter is injurious to the health, but faced tea, according to the definition of adulteration given, is clearly adulterated.

Detection. The procedure is the same as for faced coffee. The tea is shaken with cold water and the liquid decanted before the detached particles have time to subside. The insoluble matter is allowed to settle; it may be collected, dried, and weighed, when the weight will allow one to form an estimate of the amount of coloring matter present. To detect the different pigments, the sediment is examined chemically or microscopically (see coffee.)

Exhausted Leaves.—The collection of exhausted tea leaves from restaurants, tea shops, etc., forms quite a business in some countries. The refused leaves are dried, given the required color by facing, and used as an adulterant. The admixture of exhausted leaves appears to be a most common and fraudulent practice, and one not easy to detect.

Detection. Since a portion of the tea leaf is dissolved by water, exhausted tea leaves contain a lower per cent. of soluble matter, and a higher per cent. of insoluble, than fresh leaves. The percentage of soluble or insoluble constituents forms a basis for an opinion as to the presence or absence of exhausted leaves. Total ash, insoluble ash, and insoluble leaf give the most reliable indications. By total ash is meant the per cent of residue left on burning the tea; by insoluble ash, the portion of this residue insoluble in water. The difference is of course the ash soluble in water. Insoluble leaf is the percentage of insoluble matter left by treating the tea with successive portions of hot water until

all soluble matter is removed. The percentage of insoluble leaf is much higher in an exhausted tea than in a fresh tea, the per cent. of total ash lower unless the tea is faced. It would be an easy matter to determine if tea is composed entirely of exhausted leaves, but exhausted tea is used to mix, used as an adulterant, and in a mixture the problem is much more difficult. If pure tea were constant in composition the admixture of spent tea would be easily detected, but tea varies considerably in composition; the percentage of total ash, insoluble ash, insoluble leaf, vary greatly from sample to sample of tea known to be pure. The appearance of the leaves is a great aid in rendering a decision. If they are frayed, partly unrolled, or mnch broken, there is evidence of spent tea. When individual exhausted leaves can be separated, the results of an analysis would be conclusive. Standards have been adopted by many chemists to aid them iu rendering a decision; thus, if the insoluble leaf is over 60 per cent., or the total ash is lower than 4.5 per cent., or the ash soluble in water less than 40 per cent. of the total ash, the tea is likely to be condemned. These standards have been formulated as the result of many analyses, and are intended to condem no pure tea.

Foreign Leaves.—The Chinese occasionally employ ash, camelia, and dog rose leaves as tea adulterants, and leaves from the sloe, willow, beech, hawthorn, etc., have been used. Such leaves are at present a rare adulteration. Battershall states that foreign leaves were present in only a few samples of the 2,000 suspected teas examined under his direction for the purpose of enforcing the United States Tea Adulteration Act.

Detection. Leaves from different kinds of plants vary greatly in their shape, arrangement of veins, and in the minute details of their structure. The suspected leaves are soaked in hot water, carefully unrolled on a glass plate, and examined with a small lens. Those familiar with the tea leaf may usually identify even small fragments in this manner. In cases of doubt the microscope is used. The structure and arrangement of the cells which make up a tea leaf are so different from that of other leaves that the microscope will furnish conclusive evidence whether a leaf, or even the powder of a leaf, is from the tea or some other plant.

Astringents.—These are added to make a tea appear stronger than it really is Catechu, a powerful astringent, sometimes used, is detected by boiling the tea infusion with an excess of litharge, and bringing the filtrate from this in contact with a dilute solution of ferric chloride. A green precipitate shows catechu. Iron salts, also used as astringents, are detected by the usual qualitative tests for iron in the solution obtained by the action of dilute acetic acid on the tea.

EXAMINATION OF SAMPLES BOUGHT ON THE OPEN MARKET.

DESCRIPTION OF SAMPLES.

Laboratory Number.	Name.	Price per Pound.	Where Purchased.
1065	Royal Pekin, mixed	.60	Statesville.
1066	Austin & Co., black	.40	Statesville.
1067	Austin & Co., black	.60	Statesville.
1068	Austin & Co., black	.80	Statesvi le.
1069	Austin & Co.. green	.60	Statesville.
1071	He-No, mixed	.80	Raleigh.
1072	Deboy & Co., mixed	.40	Raleigh.
1073	Gunpowder, green	.60	Raleigh.
1074	Black tea	.40	Raleigh.

Facing.—The following samples were faced:

1065, facing contained black lead.

1067, facing contained black lead.

1069, facing contained Prussian blue.

1073, facing contained Prussian blue.

Of 9 teas, 4 or 44 % were faced.

Exhausted Leaves.—The determination of insoluble leaf, total and insoluble ash were made according to the methods given in Bulletin 13, Division of Chemistry, U. S. Department of Agriculture. The results are given in the table.

Number.	Insoluble Leaf.	Total Ash.	Soluble Ash.	Per Cent. Soluble Ash of Insoluble Ash.
1065	47.80	6 07	3 63	59.8
1066	59 15	6 06	3 04	59.2
1067	53.17	6.45	3.99	61.9
1068	49.96	6.37	4.05	63 6
1071	53.08	6.05	3.96	65.4
1072	53.38	5.98	3.60	60.2
1073	53.35	7.46	3.30	44.4
1074	53.09	6.87	3.89	56.6

There is no reason to suppose any of the teas are adulterated with spent tea leaves.

Foreign Leaves.—None found.

Astringents.—Iron, copper, and catechu were not present.

EFFECT OF LEGISLATION ON TEA ADULTERATION.

An act was passed by Congress in 1883, which prohibited the importation of any tea "adulterated with spurious leaf or with exhausted leaf, or which contains so great an admixture of chemicals or other deleterious substances as to make it unfit for use."

Dr. Battershall, who had charge of the chemical examination of the tea entered at New York city, states that the quality of the tea imported there has improved very perceptibly since the enforcement of the Adulteration Act.

BULLETIN No. 155. DECEMBER 20, 1898.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

W. A. WITHERS, A. M., ACTING DIRECTOR

BAKING POWDERS

ON SALE IN NORTH CAROLINA.

W. A. WITHERS AND J. A. BIZZELL.

RALEIGH, N. C.

500

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M....................Professor of Chemistry.
F. E. EMERY, M. S......................Professor of Agriculture.
W. F. MASSEY, C. E.....................Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D.........Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.

F. E. EMERY, M. S......................Agriculturist.
W. F. MASSEY, C. E.....................Horticulturist.
COOPER CURTICE, D. V. S., M. D.........Veterinarian.
A. W. BLAIR, A. M......................State Chemist.
C. B. WILLIAMS, M. S...................Assistant Chemist.
H. K. MILLER, M. S.....................Assistant Chemist.
C. D. HARRIS, B. S.....................Assistant Chemist.
J. A. BIZZELL, B. S....................Assistant Chemist.
F. G. KELLY............................Assistant Chemist.
W. G. HAYWOOD, B. LITT.................Assistant Chemist.
ALEX. RHODES...........................Assistant Horticulturist.
C. W. HYAMS............................Assistant Botanist.
J. M. JOHNSON, M. S....................Assistant Agriculturist.
B. S. SKINNER..........................Farm Superintendent.
J. M. FIX..............................Secretary.
H. E. KING.............................Chief Clerk.
C. M. HUGHES, B. E.....................Clerk.
MISS M. S. BIRDSONG....................Stenographer.
MRS. L. V. DARBY.......................Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

*BAKING POWDERS ON SALE IN NORTH CAROLINA.

W. A. WITHERS, A. M., CHEMIST,
J. A. BIZZELL B. S., ASSISTANT CHEMIST.

AERATION OF BREAD.

The greater quantity of bread consumed by man is leavened, *i. e.*, it is soft and spongy. The leavening process consists simply in the generation of carbonic acid gas within the dough. On expanding, through natural pressure, or under the influence of heat, a porous, spongy condition is produced in the dough, and on baking this condition remains fixed.

The methods for the production of carbonic acid gas in bread-making belong to the following three classes: (1.) Introduction into the dough of previously prepared gas. (2.) Fermentation, *i. e.*, generation of gas within the dough through the presence and activity of certain germs. (3.) Generation of gas within the dough by use of certain chemical agents. Baking powders are included in the third class.

The first of these methods is only of historical importance. It has not proven of practical application, so will not be spoken of further.

The second method provides for the generation of carbonic acid gas through the process of fermentation. Fermentation depends on the activity of certain germs, which are usually added in the form of yeast. The gas is formed from the natural constituents of the flour, hence nothing is introduced into the bread which would in the slightest degree be unwholesome. Yeast is used extensively for bread. In fact, nothing else has been found to be so efficient. There is, however, an objection to its use—generation of gas takes place slowly. The frequent necessity of having bread "raised" quickly has caused the introduction of chemical agents.

The two essential constituents of a baking powder are: (1.) A carbonate, which contains the carbonic acid gas in chemical combination. (2.) An acid constituent, which, when mixed with the carbonate and brought into solution with water, liberates the gas. Sodium bi-carbonate or "baking soda" is almost exclusively used for the first constituent. There is a variety of acid constituents.

These compounds do not act upon each other readily when mixed together in the solid state, but when brought into solution with water, chemical action takes place readily, and carbonic acid gas is liberated. The solid products of the chemical action are not removed by baking, as some manufacturers would have us believe, but remain in the bread and are eaten with it.

---

*NOTE.—In the preparation of this bulletin we desire to acknowledge the use of much valuable information taken from Bulletin 13, part 5, United States Department of Agriculture, Division of Chemistry.

Sour milk is very commonly used with "baking soda" for leavening bread. In this operation the lactic acid of the sour milk constitutes the acid ingredient. The same kind of chemical action takes place when baking powders are used as when sour milk is made use of.

CLASSIFICATION OF BAKING POWDERS.

Baking powders may be classified according to the nature of their acid ingredients. The three principal kinds are recognized as follows:

(1.) Tartrate powders, in which the acid constituent is tartaric acid in some form.

(2.) Phosphate powders, in which the acid constituent is phosphoric acid.

(3) Alum powders, in which the acid constituent is furnished by the sulphuric acid contained in some form of alum salt.

All powders sold at present will come under some one of these heads, although there are many powders which are mixtures of at least two different classes.

Tartrate Powders.—The form in which tartrate acid is almost exclusively used in this class is bi-tartrate of potassium or "cream of tartar." Bi-tartrate, or acid tartrate of potassium contains one atom of replaceable hydrogen, which gives it the acidity that acts upon the carbonate. The reaction takes place according to the following equation:

$$\underbrace{KHC_4H_4O_6}_{\text{Potassium bi-tartrate}} + \underbrace{NaHCO_3}_{\text{Sodium bicarbonate}} = \underbrace{KNaC_4H_4O_6}_{\text{Potassium sodium tartrate}} + \underbrace{CO_2}_{\text{Carbonic acid gas}} + \underbrace{H_2O}_{\text{Water}}$$

From the above reaction it will be seen that the residue left from the use of a tartrate powder is a double tartrate of potassium and sodium. This compound is ordinarily called Rochelle salt, and is the compound formed when the two component parts of a seidlitz powder are moistened and mixed. A loaf of bread made from one quart of flour using a tartrate powder contains about one-third more crystallized Rochelle salt than is contained in one seidlitz powder. The character of this residue is probably the least objectionable of any of those left by baking powders. Rochelle salt is used as a mild purgative.

Phosphate Powders.—The salt commonly used to furnish the phosphoric acid in this class is mono-calcium phosphate $CaH_4(PO_4)_2$ or acid phosphate of lime. This compund in a more or less pure state is sold as a fertilizer. It is purified, however, for use in baking powders, but the gypsum which is formed in its production is difficult to remove, hence most phosphate powders contain considerable quantities of this impurity.

The following equation represents fairly well the action between moro-calcium phosphate and bi-carbonate of soda:

$$CaH_4(PO_4)_2 + 2NaHCO_3 = CaHPO_4 + Na_2HPO_4 + 2CO_2 + 2H_2O$$

Mono-Calcium Phosphate — Bicarbonate of Soda — di-Calcium Phosphate — di-Sodium Phosphate — Carbonic acid Gas — Water

The residue remaining in the bread from the above reaction consists of di-calcium phosphate and di-sodium phosphate. Taking into consideration the fact that these compounds take up water of crystalization and weigh more than is represented in the equation, we find that the quantity of chemicals left in the dough is fully equal in weight to the amount of baking powder used. As to the nature of this residue it would seem to be about as unobjectionable as the residue from the tartrate powders. Disodium phosphate is a mild purgative, in doses of from one to two ounces. The action of di-calcium phosphate is not well understood.

Alum Powders.—In this class of powders the acid constituent necessary for the liberation of carbonic acid gas is furnished by one of the general class of compounds, known as alums. The alums are composed of a double sulphate of aluminum and an alkali metal. When used in a baking powder the aluminum is left as the hydroxide, while the sulphuric acid, thereby liberated, goes to set free the carbonic acid gas in the bicarbonate of soda. The alum of commerce is either potash alum or ammonia alum, the one or the other predominating according to their relative cheapness.

The following shows the reaction taking place in a baking powder, made with burnt ammonia alum, *i. e.*: ammonia alum, from which the water of crystalization has been driven by heat:

$$(NH_4)_2Al_2(SO_4)_4 + 6NaHCO_3 = Al_2(OH)_6 + 3Na_2SO_4 + (NH_4)_2SO_4 + CO_2$$

Burnt Ammonia Alum — Bicarbonate of Soda — Hydrate of Aluminum — Sulphate of Soda — Sulphate of Ammonia — Carbonic acid Gas

If potash alum were used the reaction would be precisely the same with the substitution of potassium for ammonium, whenever it occurs in the equation.

Reference to the above equation will show that the residue consists of sulphate of soda, sulphate of ammonia, and hydroxide of aluminum, and is therefore more complicated than those previously discussed. Sulphate of soda and sulphate of ammonia seem to have no marked effect on the digestion. The residue of aluminum hydroxide is insoluble in water, but deserves special mention. It constitutes about 16 % of the total quantity of chemicals used. With reference to the effect of alum, Dr. Danglish* has said: "Its effect on the system is that of an astringent, producing constipation and deranging the process of absorption." The influence of alum on health, in the quantities in which it is usually added to bread, is still an open question with scientists. The residue is soluble in the juices of the body, and is thus absorbed by it, a fact which many manufacturers deny. The use of alum in bread-making is prohibited in countries having food adulteration laws. Unfortunately, lack of agreement among in-

*Hassall's Food, its adulterations and methods for their detection.

vestigators has prevented positive conclusions as to the harmfulness or heartlessness of the alum residue. The use of alum in baking powders is questionable, therefore. It is not too much to ask, therefore, that customers be given the opportunity of knowing when they use baking powders made from alum.

Alum and Phosphate Powders.—Some powders are met with which have been made up with various proportions of different acid ingredients, and which belong, therefore, to more than one of the above mentioned classes. The most common of these combinations is the 'alum phosphate mixture." The following equation represents the chemical change which takes place:

$$\underset{\text{Ammonia Alum}}{(NH_4)_2Al_2(SO_4)_4} + \underset{\text{Acid phosphate of Lime.}}{CaH_4(PO_4)_2} + \underset{\text{Bicarbonate of Soda.}}{4NaHCO_3} = \underset{\text{Phosphate of Aluminum.}}{Al_2(PO_4)_2} +$$

$$\underset{\text{Sulphate of Calcium.}}{CaSO_4} + \underset{\text{Sulphate of Ammonia.}}{(NH_4)_2SO_4} + \underset{\text{Sulphate of Soda.}}{2Na_2SO_4} + \underset{\text{Carbonic Acid Gas.}}{4CO_2} + \underset{\text{Water.}}{4H_2O}$$

It will be seen that the aluminium contained in this residue is held as phosphate of aluminium, which is about as soluble in the juices of the body as the aluminium hydroxide residue from the straight alum powders. Sulphate of lime, being deficiently soluble, is not absorbed to any appreciable extent by the body Sulphate of soda, and sulphate of ammonia have already been discussed.

Collection of Samples.

Samples for analysis were bought from dealers in Raleigh, Statesville, Durham, Henderson and Wilmington. In collecting samples our object has been to obtain the most common brands on sale in the State.

Methods of Analysis.

Our work has been directed toward determining the strength of the powders, or their yield in carbonic acid gas, and their composition, so far as to indicate the class to which each belongs. The amount of starch, or other legitimate filling, therefore, was not considered. The methods used were those used by the United States Department of Agriculture, Division of Chemistry, Bulletin 13, Part Fifth.

Results of Analysis.

The following tables give the results of our analyses:

I. Tartrate Powders.

Laboratory Number.	Brand.	Name and Address of Manufacturer.	Place Purchased.	Carbonic Acid Gas Per Ct.
1063	Royal	Royal Baking Powder Co., N. Y..	Statesville ..	10 55
1078	Cream	Price Baking Powder Co., N. Y	Raleigh....	12.06

II. ALUM POWDERS.

LABORATORY NUMBER.	BRAND.	NAME AND ADDRESS OF MANUFACTURER.	PLACE PURCHASED.	CARBONIC ACID GAS PER CT.
1064	Good Luck..	Southern Mfg. Co., Richmond, Va.	Statesville..	16.04
1075	Magnolia Pepsin.	Magnolia Mfg. Co., Petersburg, Va.	Raleigh....	11.19
1076	Parrot and Monkey.	The Sea Gull Specialty Co., Baltimore, Md.	Raleigh....	13.90
1077	Good Luck...	Southern Mfg. Co., Richmond, Va.	Raleigh....	15.41
1079	Free Silver...	Roanoke Chemical Co., Roanoke, Va.	Raleigh....	14.32
1163	Success......	Morehouse Mfg. Co., Savannah, Ga.	Durham...	16.40
1166	Bob White...	Miami Mfg. Co., 150 Reade Street, New York.	Durham...	6.34
1167	Free Coinage.	Manufactured for J. M. Gray, Washington, N. C.	Durham..	6.93
1169	Possum......	Savannah Soda Co., Savannah, Ga	Durham...	9.79
1197	Blue Ribbon.	Blue Ribbon Baking Powder Co., Richmond, Va.	Henderson.	13.83
1200	Safety.......	Ballard and Ballard Co., Louisville, Ky.	Henderson..	9.61
1211	Campbell's.	The Potter, Porlin Co., New York.	Charlotte..	10.34
1264	Rising Sun.	Goldsboro Chemical Co., Goldsboro, N. C.	Wilmington.	13.65
1263	Railroad.	Morehouse Mfg. Co., Savannah, Ga.	Wilmington.	12.46

III. PHOSPHATE POWDERS.

1164	Rumford...	Rumford Chemical Works, Providence, R. I.	Durham...	10.46
1201	Horsford...	Rumford Chemical Works, Providence, R. I.	Henderson..	* 8.45

*In this powder the two ingredients are put up in separate packages. The percentage given is calculated upon the combined weight of the two packages.

IV. ALUM AND PHOSPHATE POWDERS.

1062	Rolan.......	Smith, Harpel & Co., Balt., Md.	Statesville..	2.62
1165	Old Dominion	Old Dominion Mfg Co., Richmond	Durham....	11.23
1168	Rex........	J. D. and R. S. Christian Co., Richmond Va.	Durham....	10.86
1199	Purity......	Patapsco Baking Powder Co, Baltimore, Md.	Henderson.	0.22
1209	One Spoon..	Taylor Mfg Co., New York.	Charlotte...	12.93
1210	Davis O. K..	R. B. Davis, 90 West Broadway, New York.	Charlotte...	3.83

V. TARTRATE POWDER CONTAINING SMALL QUANTITY OF ALUM.

1198	Home.	Home Baking Powder Co., Charlottesville, Va.	Henderson.	0 075

Conclusions.

It is evident that the percentage of carbonic acid gas in a baking powder would vary more or less according to the time elapsing between its manufacture and analysis. This is shown by the analysis of the same brand obtained at different places. On account of this deterioration it is very important that the baking powders should be fresh, in order to get the best results.

It is a noticeable fact, however, that 56 per cent. of the samples examined were straight alum powders, while 81 per cent. contained alum. As previously stated, the use of alum in baking powders is questionable, at any rate it should not be present in a baking powder unless the fact is plainly stated on the package.

Numbers 1198 and 1199 deserve special mention. It will be noticed from the tables that these powders contained only a trace of the essential constituent of a baking powder. In fact they would be absolutely worthless in bread making. No dates were found on the packages, and each appeared to be very old. It is very probable that the absence of carbonic acid gas was due to the age of the powders.

Recommendations.

Our investigations show the great necessity of adopting some method for the regulation of the sale of baking powders.

The following extract in regard to the subject is taken from Bulletin 13, Part Fifth, United States Department of Agriculture, Division of Chemistry: "The best plan for the regulation by law of the sale of baking powders in the present condition of our knowledge of their effect upon the system, would seem to be to require the manufacturer to use a label giving approximately the composition or analysis of the powder sold. The testimony that has been adduced is hardly sufficient to justify prohibition of the sale of the cheaper kinds of powders as being injurious to health, but if they were required to be sold with a label, giving their true composition, it would soon lead to investigations upon this point. * * * It is manifestly unjust to the public to allow the sale of a first-class tartrate powder and an alum powder as the same article, and it is equally unjust to the manufacturer of the high-priced article. The nature of the substance is such that the purchaser has no means of ascertaining by any simple or easy means the character of the article he buys, to say nothing of its relative quality. Such a regulation would meet with the approbation of all concerned in the manufacture of baking powders. The manufacturer of high grade powders, such as tartrate or phosphate powders, would certainly not object to it, and it would ultimately be to the advantage also of the cheaper sorts, such as alum powders, provided they could succeed in proving that such powders produced little or no injury to the health of the consumer."

BULLETIN NO 156 DECEMBER 21, 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

THE ADULTERATION OF FLOUR

AS IT IS FOUND TO EXIST IN SAMPLES PURCHASED UPON THE MARKETS IN NORTH CAROLINA.

W. A. WITHERS AND G. S. FRAPS.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

BOARD OF TRUSTEES.

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M.....................................Professor of Chemistry.
F. E. EMERY, M. S............... . ...Professor of Agriculture.
W. F. MASSEY, C. E................ .... Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D......................Professor of Veterinary Science

EXPERIMENT STATION STAFF.

W. A. WITHERS., A. M, Acting Director and Chemist.

F. E. EMERY, M. S............................ ....Agriculturist.
W. F. MASSEY, C. E...Horticulturist.
COOPER CURTICE, D. V. S., M. D ....Veterinarian.
A. W. BLAIR, A. M ....State Chemist.
C. B. WILLIAMS, M. S...Assistant Chemist.
H. K. MILLER, M. S...Assistant Chemist.
C. D. HARRIS, B. S.. ....Assistant Chemist.
J. A. BIZZELL, B. S..............:...................................Assistant Chemist.
F. G. KELLY..Assistant Chemist.
W. G. HAYWOOD, B. LITT....................... ....Assistant Chemist.
ALEX. RHODES ....Assistant Horticulturist.
C. W. HYAMS...Assistant Botanist.
J. M. JOHNSON, M. S...Assistant Agriculturist.
B. S. SKINNER ....Farm Superintendent.
J. M. FIX...Secretary.
H. E. KING..Chief Clerk.
C. M. HUGHES, B. E..Clerk.
MISS M. S. BIRDSONG...Stenographer.
MRS. L. V. DARBY...Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

THE ADULTERATION OF FLOUR.

W. A. WITHERS, A. M., Acting Director.
G. S. FRAPS, B. S., Assistant Chemist

This bulletin is one of a series which has for its object the determination of the extent and character of the adulterations practiced in North Carolina.

The most common articles of food are the subject of these investigations; those which every one must consume in large quantities. Bulletins on vinegar, baking powders, coffee and tea have already appeared. Flour is supposed to be subjected to less adulteration in this country than any other article of food. Nevertheless, its purity is not a thing to be assumed without question, as shown by the facts presented below.

Acknowledgment.

In the preparation of this bulletin use was made of the well known works of Hassall, Blyth, and Battershall, on food adulteration, and of Sadtler's Industrial Organic Chemistry. Special mention is due the service rendered by Bulletin 13, Division of Chemistry, United States Department of Agriculture. This bulletin, on Foods and Food Adulterations, prepared under the direction of Dr. Harvey W Wiley, is composed of several parts. The last part is devoted to cereals and cereal products; frequent quotations from it will be found in the following pages.

Flour.

Milling. A grain of wheat consists of three parts, the germ, the floury matter, and the outer covering. It is really an embryo plant packed together with sufficient food to give it a good start in life, and surrounded by layers of a protective tissue. The germ, floury matter, and outer covering differ much in composition, color, and other properties, and are not of uniform character themselves. The most primitive way of preparing flour is to crush or grind the whole grain. In the next stage, the outer envelope or bran is removed from the flour by sifting. The process became more and more complex, and the wheat grain is now separated into a great number of products, each with certain distinct characteristics. Until about twenty-five years ago wheat was simply ground between stones, sifted through bolting cloths of different degrees of fineness, and separated into bran and two or three other pro-

ducts, as shorts, middlings and flour. In the high-grade roller mills of the present day from 80 to 100 products are formed from the time the wheat enters the mill until the finished products are offered for sale. The mill is called a roller mill because steel rollers replace the old-time mill-stone, rollers arranged in pairs with spiral grooves of various degrees of depth and fineness, revolving towards each other. The grain passes from a coarse set of rollers to a bolter, or sifting cloth, the products to finer rollers, and so on. It is reduced in fineness step by step, thus permitting a more perfect separatiou of the different parts of the wheat, and the practically entire separation of the bran and the germ from the starchy products of the grain. The miller does not offer 80 to 100 things for sale. These are only intermediate stages : the waste parts are mixed and sold for cattle feeding, as bran, shipstuff, etc., and from the others are compounded flours of different qualities. All the high grade mills produce several grades of flour from the same sample of wheat. The highest grade is usually called a "Patent" flour, then follow, in order of decreasing quality, "Straight," "Clear," and "Extra" flours. This method of nomenclature is not adopted by all millers; some call their lower grades "Family," "Bakers," and "Red Dog" flours. The grading of flours depends upon the miller, who is guided more by color and general appearance than anything else.

Composition.—Chemical analysis will give a basis for calculating the value of a food to the animal organism, which value must not be understood as the same as market value. Flour consists mainly of starch, and a substance containing nitrogen called gluten, which is an albuminiod. The substance the chemist calls albuminiods or protein is ueeded by the animal organism for the building and repair of the body, to make blood, muscle, bone. Oils, fatty substances, and carbohydrates as starch and sugar, are needed by the body for fuel to furnish heat to keep it warm, to furnish muscular strength for its work. The amount of these two classes of nutrients present determines in general the usefulness of the food to the body. The nutritive value of a food can be measured by the muscle-forming material it contains and the heat it will supply ; it can be expressed in terms of protein and heat. Muscle is more expensive than fuel—the frame of the locomotive is worth more than the coal it consumes. The heat-unit is called *calorie*, and is the amount of heat required to raise the temperature of 1 gram (.0353 oz.) water 1 degree Centigrade. The following table* gives the composition of different classes of flour, and allows a comparison of their value for food, according to present standards. For the purpose of comparing the food values, only the results in the first two columns need be regarded. A glance at the table shows that

*Bull. 13, Division of Chemistry, U. S. Department of Agriculture.

the Bakers and Family flours contains a greater per cent. of muscle-forming material, and will furnish more heat to the ounce than either of the other classes. The Patent flour, so far as its use as a nutrient is concerned, is worth no more than common market flour, and less than Bakers flour. Yet the Patent flour sells for more than the others. This brings out very clearly the fact that the price of a flour bears no relation to its value as a food; what it brings in the market is entirely independent of its chemical composition, and is based upon color, taste and other similar characteristics.

	Calories per Gram.	Protein Nx5.70.	Carbohydrates Nx5 70.	Fats. (Ether Extract.)
Patent Flour—40 Samples.				
Maximum	4,040	13.62	79.88	1.86
Minimum	3,707	6.23	71.94	0.32
Average	3,858	9.62	76.14	1.02
Common Market Flour—19 Samples.				
Maximum	4,156	14.54	80.41	3.84
Minimum	3,790	6 06	70.29	.34
Average	3,882	9.28	76.53	1.30
Bakers and Family Flour—14 Samples.				
Maximum	4,072	13.65	71.89	1.97
Minimum	3,811	9.10	78.85	.82
Average	3,929	11.20	74.98	1.30

The Adulteration of Flour.

The full definition of adulteration, as clearly stated in the law of the State of North Carolina, has already been quoted in full in a preceding bulletin (Coffee and Tea, No. 154). That definition need not be repeated here.

A flour is adulterated, (1) if any substance has been mixed with it so as to reduce or lower or injuriously affect its quality or strength; (2), if any inferior or cheaper substance has been substituted wholly or in part for the article; (3), if it has been treated in any way whereby damage is concealed, or it is made to appear better than it really is.

The works on food adulteration state that in the United States adulterated flour is of extremely rare occurrence. This is due to its cheapness. If the price of flour rises, there is increased danger of admixture. It is therefore well to know those substances which have been mixed with flour, and the chief methods of detecting them. But this work will show that, in spite of the cheapness of flour, it is adulterated to a considerable extent. The assumption that any flour is unadulterated is unwarranted, and it should be subjected to as severe an examination as any other article of food.

I. Vegetable additions. The following substances have been detected as adulterations in flour: Rye flour, rice meal, barley meal, potato flour, linseed meal, buckwheat flour, corn flour, and

the flour of various leguminosae, as peas, beans. With the exception of corn flour or corn meal, all these are of rare occurrence in this country.

"In regard to the use of Indian-corn meal for mixing with wheaten flour in this country, a prominent army officer of large experience in the Commissary Department, under date of March 20, 1897 gives the following information:

The Indian-corn flour used in adulterating wheat flour is especially prepared at at least two mills in this section of the country, one in Cincinati and the other in Kansas, and such Indian-corn flour is not put upon the market at all. It is made and solely prepared for use in adulterating wheat flour. To an unpracticed eye the corn flour made at the Cincinnati mill, without any mixture, could be passed off as spring-wheat flour. It has the same feel and the same appearance to the inexpert; of course it lacks taste and color when critically examined, but it is of such a nature that it is difficult to detect it in mixtures even though in very large proportions."—*Bulletin 13, Division of Chemistry, U. S. Department of Agriculture.*

As will be seen, corn flour was detected in several of the samples examined in the course of this investigation.

After corn flour, the most probable vegetable adulterant of American flour would be pea flour, and then bean flour. The wider-spread growth of the cow-pea in the Southern States, and its cheapness, would lead one to be on the watch for its appearance ground with flour.

Detection. Wheaten flour, as well as the flours of the vegetable substances sometimes mixed with it, consists largely of starch. The appearance of starch when highly magnified shows its origin. Starch possesses an organized structure which differs in different kinds of plants. Under the microscope wheat flour is seen "to consist of different grains or particles; many of these are very small, others are of considerable dimensions; the small grains are chiefly round, rarely oval, and for the most part provided with a central spot or hilium: the larger granules form rounded or flattened discs, with thin edges."* The granules of rice starch and corn starch are angular, and have a well defined star or depression in the center. Pea starch and bean starch have an oval shape, and a prominent central mark, a long, more or less stellate, air-filled black hollow. Potato starch is made up of concentric rings, has an excentric hilium, and gives a play of colors with a selenite plate and polarized light. Wheat starch does not appear colored under these conditions. These and other differences enable one who is familiar with the starches to determine the plant from which a particular starch came, or to decide whether it is

*Hassall.

homogeneous or a mixture, by an examination with the microscope. If wheat flour has been adulterated with peas or corn, the microscope will reveal it.

Chemical methods are known which can be used to detect vegetable adulterations in flour. They will not be described here.

II. *Mineral additions.* A recent Bulletin of the United States Department of Agriculture* is authority for the following: "The use of gypsum, terra alba or other inert white earthy powders has never been detected as an adulteration in flour or bread in the samples examined in this laboratory. No authentic record of such adulteration in the United States is at hand. "In *The American Grocer*, (New York,) of June 15, 1898, an article appeared containing a letter from the York Manufacturing Company, of Greensboro, N. C., offering mineraline for use as an adulterant in flour and other articles of food." Many adulterations of this kind are reported in foreign countries. In one instance a wheat flour was reported to contain 53.5 per cent. of gypsum. In nine flours examined in Gratz, one was found which contained 39 per cent. of gypsum."

This shows that those who examine flour for adulterations must always test for mineral matter.

Detection.—When pure flour is burned, the ash left seldom exceeds 0.90 %, although cases are known in which it has reached 2.0 per cent. The addition of mineral matter to flour in sufficient quantity to render its use as an adulterant profitable would increase the per cent. of ash greatly. A flour containing ten per cent. mineral matter would yield over ten per cent. ash.

III. Mineral additions to enhance apparent value. Alum, carbonate of soda and carbonate of magnesia, are added to flour to improve its appearance. Carbonate of soda and carbonate of magnesia are rarely used. Alum is employed to disguise the presence of damaged flour in mixtures, or to improve the appearance of an inferior grade; its addition to a damaged flour serves to arrest decomposition of the gluten, thereby preventing the flour from acquiring a dark color and disagreeable odor and taste.

Alum in appreciable quantities is injurious, having a retarding influence on the digestion. In the small quantity in which it is added to flour, alum may or may not impair the health; that question is still unsettled. But since alum is added for the purpose of causing the purchaser to believe he is obtaining a better article than he really does, there can be no difference of opinion that it is a serious adulteration, and not to be permitted. According to the definition already given, the presence of alum is a clear case of adulteration.

Detection.—The flour is made into a paste with a little water and a few drops of an alcoholic solution of logwood; a little am-

*Bulletin 13, Division of Chemistry.

monium carbonate is then added. If alum be present the color changes to lavender blue, while, if no alum is present, the resulting tint is only a faint pink. Another method may be used, which consists in separating the alum, as such, from the flour. A quantity of the flour to be tested is shaken with chloroform in a separating funnel, and allowed to stand. The alum sinks to the bottom, together with other mineral matter and some flour. The subsided particles are separated and treated with chloroform as before. The alum is dissolved from the particles, which sink with water, and is identified by its properties.

Examinations of Samples of Flour.

The samples were collected from stores of different grades, most of them by purchase. The last three samples, numbers 10561, 10673, 10645, were sent to the Station as suspicious flours by parties not connected with the Station. The table gives a description of the samples.

Most of the samples in the table came from flours which were sold in packages as small as one-sixteenth of a barrel—or 12¼ lb. sacks. Some few were sold in half-barrel sacks only.

DESCRIPTION OF SAMPLES.

Date Obtained.	Serial Number.	Brand.	Manufacturer.	Where Obtained.
1898. June 18	1026	....	....	Raleigh.
	1027	Imperial	....	Raleigh.
	1028	Jersey Lily	....	Raleigh.
	1029	Royal Patent........	....	Raleigh.
	1030	....	....	Raleigh.
July 12	1031	Jeff Davis........	Sweet Water Milling Co., Sweet Water, Tenn.	Statesville.
	1032	Royal Straight....	Rayner, Miller & Co........	Statesville.
	1033	"Extra Choice"..	Fresno Milling Co	Statesville.
	1034	Oven Lifter......	Statesville Roller Mills	Statesville.
	1033	Sylvan Bell.......	Sweet Water Mills Co., Sweet Water, Tenn.	Statesville.
	1036	Carolina Choice...	Statesville Roller Mills	Statesville.
	1037	Dan Valley	Dan Valley Mills, Danville, Va.	Statesville.
	1038	De Soto...........	Dan Valley Mills, Danville, Va.	Statesville.
	1039	Oak Ridge........	Dan Valley Mills, Danville, Va.	Statesville.
	1040	Cedar Cliff........	Dan Valley Mills, Danville, Va.	Statesville.
Aug. 22.	1145	Royal Crown.......	Stuart Draft Milling Co., Stuart Draft, Va.	Raleigh.
	1146	Bon Ton Patent...	White Star Mills, Staunton, Va.	Raleigh.

Date Obtained.	Serial Number.	Brand.	Manufacturer.	Where Obtained.
	1147	City Pride........	Farina Roller Mills, Raleigh, N. C.	Raleigh.
	1148	Golden Star.......	New Market Roller Mills, New Market, Va.	Raleigh.
	1149	Oak City Straight	Farina Roller Mills, Raleigh..	R aleigh.
	1150	Calla Lily	White Star Mills, Staunton, Va.	Raleigh.
	1151	Acme Patent......	Strasburg Steam Flouring Mills, Strasburg, Va.	Raleigh.
	1152	Obelisk Patent....	Ballard, Louisville	Raleigh.
Sept. 15.	1159	Monarch..........	J. I. Triplet, Woodstock, Va .	Durham.
	1160	White Rock	S. C. Hurts & Son, Lynchburg, Va.	Durham.
	1161	White Violet.....	Strasburg Flour Mills, Strasburg, Va.	Durham.
	1162	Snow Flake.......	———, Strasburg, Va........	Durham.
Sept. 17.	1172	Roller Champion .	....	Raleigh.
	1173	White Rose.......	....	Raleigh.
	1174	Melrose	———, Staunton, Va	Raleigh.
	1175	Nickel Plate......	Model Mills, Nashville, Tenn.	Raleigh.
	1176	Panola	Model Mills, Nashville, Tenn.	Raleigh.
	1178	White Flint.......	....	Raleigh.
	1179	Union............	———, Tenn	Raleigh.
	1180	Magnolia.........	———, Virginia............	Raleigh.
	1181	Pride of the Valley	———, Stephens City, Va..	Raleigh.
	1182	Imperial	Crickenberger & Hottel, New Market, Va.	Raleigh.
	1183	Purity............	Strasburg Steam Flouring Mills Strasburg, Va.	Raleigh.
	1184	Water Lily	Strasburg Steam Flouring Mills, Strasburg, Va.	Raleigh.
	1185	....	———, North Carolina	Raleigh.
	1186	Crescent	———, Tennessee...........	Raleigh.
	1187	New Process	White Star Mills, Staunton, Va.	Raleigh.
	1188	Waverly.........	Strasburg Steam Flouring Mills.	Raleigh.
	1189	Waterloo..........	Ballard, Louisville	Raleigh.
	1203	Old Gold.........	Strasburg Steam Milling Co..	Henderson.
	1204	Royal Patent......	White Star Mills, Staunton, Va.	Henderson.
	10561	Canopy	Cumberland Mills, Nashville, Tenn.	Scotland Neck.
	10673	Biltmore Patent..	Asheville Milling Co , Asheville, N. C.	Asheville.
	10645	Golden Sheaf.....	....	Fayetteville.

I. Vegetable adulterations.—An examination with the microscope showed that the following flours were adulterated:

1031. Jeff. Davis, 6.6 per cent. corn flour.
1035. Sylvan Bell, 7.6 per cent. corn flour.
1040. Cedar Cliff, 10.6 per cent. corn flour.
1179. Union, 12.5 per cent. corn flour.
1186. Crescent, 20 per cent corn flour.

1189. Waterloo, corn meal. Not determined.
10645. Golden Sheaf, 39 per cent. corn flour.
10561. Canopy, 12.3 per cent. corn flour.

All of the above were cheap flours. None of the patent flours contained any adulterant. Numbers 1179 and 1186 were only in half-barrel sacks. Number 1189 contained a quantity of corn meal, the percentage of which could not be determined by the method described below.

Fifty samples flour examined; eight samples adulterated with corn flour or corn meal—16 per cent.

Determination of corn flour in wheat flour.—The only method available is very approximate. Dr. Ewell describes it in full in the Journal of Applied Microscopy, Vol. 1, page 122. Briefly, the method is as follows: One gram of the sample is well mixed with 20 cc of a mounting fluid composed of glycerine, acetic acid and water, and a drop of the mixture placed on a slide for examination under the microscope. The number of corn starch granules and wheat starch granules visible in a certain field are counted, using a slide divided into squares in the eye-piece of the microscope as an aid. One thus counts ten fields of view, and calculates the ratio of corn starch to wheat starch granules. A mixture of known composition is subjected to the same treatment, and from the ratio of the granules in this, the composition of the unknown flour is calculated. The method is approximate only. Working on mixtures of corn starch and flour, prepared in proportions unknown to him, Ewell obtained 29.3 per cent., 3.83 per cent., and 16.0 per cent. corn starch, instead of 32.5 per cent., 7.75 per cent., and 21. per cent respectively, and the writer calculated 8.5 per cent. in mixture instead of 5.0 per cent., which was its true composition.

If a sample of the adulterant could be used to make the standard mixture, the result would approximately represent the percentage of adulteration. Such a sample cannot be obtained, and corn starch had to be used, so that not the per cent. of adulteration, but of corn starch, is reached. The average amount of starch in Indian corn flour analyzed by the U. S. Department of Agriculture is 78.4 per cent. With this figure as a basis, and determining the amount of corn starch in the flours by the method just described, the percentages of adulteration was reached which are given in the above table.

II. Mineral additions.—No clay, soapstone, mineraline or any other such minerals were detected in any of the flours examined. The per cent. of ash in the flours is given in the table.

PERCENTAGES OF ASH.

SERIAL NO.	ASH.	SERIAL NO.	ASH.	SERIAL NO.	ASH.
1026	0.30	1037	0.38	1161	0.41
1027	0.45	1039	0.49	1162	0.43
1028	0.44	1040	0.77	1172	0.39
1029	0.32	1145	0.34	1173	0.52
1030	0.39	1146	0.34	1180	1.05
1031	0.64	1147	0.48	1183	0.46
1032	0·51	1149	0.46	1184	1.06
1033	0.71	1150	0.36	1185	0.68
1034	0.80	1151	0.38	1187	0.39
1035	0.47	1152	0.41	1189	0.65
1036	0.49	1159	0.41	10645	0.48
1037	0.36	1160	0.47	10561	0 43
				10673	0.34

III. Mineral additions to enhance apparent value.

Twenty-seven of the flours were subjected to the logwood test for alum. In one case only was alum found:

No. 1031, Jeff Davis.

One in twenty-seven, or almost 4 per cent.

SUMMARY.

American flour is adulterated with corn flour. Mills exist which have the preparation of corn flour for use as an adulteration their only object.

Sixteen per cent. of the flours examined by us contained corn flour.

If the number of Patent flours examined were left out of consideration, and only the cheap flours regarded, over twenty per cent. were adulterated with corn flour.

Foreign flour is adulterated with mineral matter, such as clay and plaster of Paris.

Ground soapstone has been offered for sale in North Carolina for use in the adulteration of flour.

American flour sometimes contains alum. One sample examined by us contained alum. Dr. Battershall states that this is the most common adulterant of our flour; this work seems to give corn flour the leading place as an adulterant of wheat flour.

A national law requires an internal revenue stamp affixed to packages of flour with which corn flour has been mixed. Without some one to execute the law it is without effect.

BULLETIN No. 157 DECEMBER 22, 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

MINERALINE

AN ADULTERANT PROPOSED FOR WHEAT FLOUR, TOGETHER WITH A REPORT OF SOME MISCELLANEOUS EXAMINATIONS FOR ADULTERATION

W. A. WITHERS AND H. W. PRIMROSE.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX Q HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M .... Professor of Chemistry.
F. E. EMERY, M. S .... Professor of Agriculture.
W. F. MASSEY, C. E .... Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D .... Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.

F. E. EMERY, M. S .... Agriculturist.
W. F. MASSEY, C. E .... Horticulturist.
COOPER CURTICE, D. V. S., M. D .... Veterinarian.
A. W. BLAIR, A. M .... State Chemist.
C. B. WILLIAMS, M. S .... Assistant Chemist.
H. K. MILLER, M. S .... Assistant Chemist.
C. D. HARRIS, B. S .... Assistant Chemist.
J. A. BIZZELL, B. S .... Assistant Chemist.
F. G. KELLY .... Assistant Chemist.
W. G. HAYWOOD, B. LITT .... Assistant Chemist.
ALEX RHODES .... Assistant Horticulturist.
C W. HYAMS .... Assistant Botanist.
J. M. JOHNSON, M. S .... Assistant Agriculturist.
B. S. SKINNER .... Farm Superintendent.
J. M. FIX .... Secretary.
H. E KING .... Chief Clerk.
C. M. HUGHES, B. E .... Clerk.
MISS M. S. BIRDSONG .... Stenographer.
MRS L. V. DARBY .... Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

MINERALINE.

AN ADULTERANT PROPOSED FOR WHEAT FLOUR.

W. A. WITHERS, A.M., CHEMIST.
H. W PRIMROSE, B.S., ASSISTANT CHEMIST.

INTRODUCTORY.

It is hardly within the province of the Experiment Station to prosecute violators of law, but we feel justified in calling the attention of the public to practices which we feel will result in much injury to our people. The adulteration of food can not be justified under any circumstances. The party who mixes an inferior or worthless article and sells it under the name of the article he imitates could hardly be classed as an honest man, and where the adulteration is injurious to the health of the consumer, he could hardly be classed as a friend of the public health. The following investigation was undertaken with a view to ascertaining the extent of an attempt to defraud our people, by the admixture of a mineral with flour. The results of that investigation are given herewith.

ADVERTISEMENT OF MINERALINE.

In the *American Grocer* of June 15, 1898, an article appeared containing a letter from the York Manufacturing Company of Greensboro, N. C., offering Mineraline for use in adulterating flour and other articles of food. The letter read as follows:

GREENSBORO, N. C., May 7, 1898.

GENTLEMEN:—We invite your attention to our Mineraline, which is, without doubt, the greatest existing discovery.

There is no flour-mill man who can afford not to use it, for several reasons.

Your flour will be much whiter and nicer; it does not injure the flour in any way, is not at all injurious to the health, and by using Mineraline you realize a margin of from $400 to $1,650 on each car load you use.

To secure a low freight rate, we mark it as "ship stuff."

We can furnish you Mineraline f. o. b. cars your station, for high grade flour, at $20 per ton; for medium grade flour at $16 per ton; for bread meal, $12 per ton; and for feed meal at $8 per ton.

For a high grade flour, use 15 per cent. Mineraline; for medium grade flour use 12 per cent. Mineraline; for bread meal use 12 per cent. Mineraline, and for feed meal use 18 per cent. Mineraline.

We furnish all our customers with a mixer, free of charge; this machine will distribute completely any proportion desired, and costs nothing to attach.

All you have to do is to bore a hole in your elevator pipe, clamp on the machine, attach a cord to run it, fill up the hopper, and set the feed to the proportion desired.

Enclosed find sample of Mineraline for medium-grade flour.

You cannot afford to let your competitor beat you in both quality and margin. We would be glad to hear from you.

Very truly yours,

THE YORK MANUFACTURING COMPANY.

The following remarks were made by the Editor of the *American Grocer:*

"We would not have believed it possible that any mineral substance could be employed in the adulteration of flour, but we have this week received from one of our correspondents the following circular. * * * We have had the samples of minerals examined by our chemist, and it seems to consist of ground soapstone. There is no excuse whatever for the use of mineral adulterants in flour. It is a crime against the community and we hope the food commissioners of the States having food laws, will keep a sharp lookout for flour adulterated with Mineraline."

INFORMATION GATHERED.

On December 3rd, 1898, nearly five months after the publication of the article in the *American Grocer* and nearly six months after the date of the circular, one of us visited Greensboro to ascertain, if possible, something of the York Manufacturing Company, the location and extent of its business and the character of the product offered for sale. There seemed to be no difficulty in ascertaining the location of the office of the Company, or what was supposed by the public to be the office of the Company, although there was no sign over the door. Apart, however, from the lack of the sign, there seemed to be no disposition to conceal the contents of the room from the public. In the office was found a fresh lot of talc, or soapstone, which the party in charge informed us had been received from Liberty, Randolph County. There were also in the room piles of different grades of the mineral. There was also in the room a mill for grinding and some of the rock which appeared to have been recently ground. There were also a dozen or two cans of varnish in the room. No objection was made to furnishing us samples of the different grades of rock and of the ground material and a suggestion was made that samples could be secured up town from the representative of the Company, who had charge of the commercial side of the business. Application was made for Mineraline at the office to which we were referred. The clerk in charge furnished us with a sample both of the ground and unground material and informed us that preparations were being made toward "adding new machinery, enlarging the business and moving nearer the mines." We were also informed by the clerk that the ground portions represented the samples which

were distributed to the public. The business agent, we regret to say, was not in his office and we were unable to see him. We may add, however, that our State Chemist has received samples of the same material for analysis, from the party represented to us as the business agent of the Company. One sample sent was contained in an envelope bearing the words "York Manufacturing Company." We examined the records of the Clerk of the Court, but failed to find that the York Manufacturing Company was incorporated. We found, however, that a company had been incorporated, a portion of whose business was "the grinding of cereals and of minerals of all kinds," and one of the incorporators is the party considered by the public as one of the leading members of the York Manufacturing Company.

EXTENT OF SALE.

It may be said to the credit of the millers that we found no evidence of the sale of the material for the purpose stated in the circular letter which has been quoted above, but it seems from the information which we gathered, that a systematic effort was made to create a demand for Mineraline.

CHARACTER OF MINERALINE.

We took a sample of the ground material to several parties who are considered good cooks and they, after a superficial examination and without cooking, pronounced it to be a fair grade of flour. If the simple ground material is such an excellent imitation of flour, it is difficult to see how, if it were mixed with flour in the proportions indicated in the circular, the busy housewife would be able to detect its presence.

CONCLUSION.

It has been our purpose to inform the public of this effort to impose upon them and to put them on their guard. We have not named individuals, but these names may be obtained if desired by the proper authorities. We wish, however, to express our disapproval of this attempt to defraud our people and to congratulate them that so far as we have been able to find out, our flour millers are too honest to be seduced by the plausible scheme presented by the York Manufacturing Company.

Miscellaneous Work.

The following samples were examined under the direction of the Chemist of the Station, and where mention to the contrary is not made, the sample was obtained by a representative of the Station.

COFFEE.

The following samples of coffee were examined for adulteration. The analytical work was done by Mr. H. K. Miller, Assistant Chemist. Further information on this subject, concerning analytical methods used, etc., may be gotten from Bulletin No. 154, of this Station.

No. 1212. Choice Roast Coffee, 10c per lb., from Austin Nichols & Co., New York, bought in Charlotte, N. C.

Broken grains, hulls and sticks, 29 per cent.; rocks 2 per cent.; cold water extract 1.25 per cent.

This coffee is adulterated with coffee screens, and is heavily glazed.

No. 1213. Merchants' Standard Oriole, 13c per lb., Merchants' Coffee Co., Baltimore, Md., bought in Charlotte, N. C.

Cold water extract, 0.51 per cent. This sample was not glazed.

No. 1214. Mistletoe Coffee, 25c per lb., roaster's name not ascertained. This sample was bought in Charlotte, N. C.

Cold water extract 0.55 per cent. This sample was not glazed.

No. 1215. Durham Special Coffee, 25c per lb. Roaster not given. This was bought in Charlotte, N. C.

Cold water extract 0.45 per cent. This sample was not glazed.

No. 1216. Four Hundred Coffee, 35c per lb., Isaac Newlin, New York, bought in Charlotte, N. C.

Cold water extract 0.50 per cent. This coffee was not glazed.

No. 1261. Choice Roasted Rio, Jeffries and Stubton, Richmond, Va., bought in Wilmington, N. C.

Sticks and hulls, 4 per cent.; cold water extract, 1.1 per cent. This sample had been glazed.

No. 1262. Morning Joy, New Orleans Coffee Co., bought in Wilmington, N. C.

Cold water extract 0.40 per cent. This was not glazed.

None of the above samples contained imitation coffee.

Glazing. Two of the above samples were glazed as is shown by the per cent. of cold water extract.

BREAD.

One sample of bread tested, as described in Bulletin No. 156, by Dr. G. S. Fraps, Assistant Chemist, gave the test for alum. This sample was purchased in Statesville, N. C.

BRAN.

One suspicious sample of wheat bran was examined by Dr. G. S. Fraps, Assistant Chemist. It was purchased near Raleigh, N. C. Microscopic examination showed that the bran was adulterated with corn products.

A sample of bran sent by a private party, and suspected by him of being adulterated, was examined by Mr. C. B. Williams, Assistant Chemist, and found to contain corn cob meal to the extent of one-fourth of the whole.

COTTON SEED MEAL.

One sample of cotton seed meal suspected of being adulterated, was sent to the Station by a private party to be examined. The percentage of nitrogen was determined by Dr. G. S. Fraps, Assistant Chemist, and found to be smaller than it ought to have been. By passing it through a sieve, the cotton seed meal was separated from cotton seed hulls. Cotton seed hulls were present to extent of about 50 per cent. of the whole.

RECENT BULLETINS.

The following are some of the recent Bulletins of the Experiment Station:

No. 97. Digestion Experiments, Fig. 1. pp. 48.
No. 98. Some Leguminous Crops and Their Economic Value, cuts 9, pp. 40.
No. 99 Thread Worm of Pork (Trichina Spiralis), cuts 9, pp. 8.
No. 100. Our Common Insects, cuts 65, pp. 36.
No. 101. The Progress of the Dairy Industry in North Carolina, pp. 8.
No. 102. Encouragement to the Dairy Industry, pp. 12.
No. 103. Miscellaneous Agricultural Topics. pp. 24.
No. 104. Why Pull Your Corn Fodder? pp. 4.
No. 105. The Chestnut and Its Weevil: Nut Culture, pp. 12.
No. 106. Rational Stock Feeding, pp. 44.
No. 107. Propagation of Flowering Bulbs in North Carolina, plates 24, pp. 24.
No. 108. Seed Testing; Its Uses and Methods, pp. 64.
No. 109. Feeding Trials With Animals, pp. 34.
No. 110. Marls and Phosphates of North Carolina, pp. 50.
No. 111. The Fertilizer Control During 1894, pp. 26.
No. 112. Trucking in the South, pp. 70.
No. 113. The Testing of Milk, cuts 4, pp. 32.
No. 114. Tests of Dairy Implements and Practices, cuts 4, pp. 32.
No. 115. Miscellaneous Agricultural Topics, pp. 20.
No. 116. Milk Records and Tests, pp. 16.
No. 117. Tuberculosis and Its Prevention, pp. 20.
No. 118. Cotton Seed Hulls for Beef Production, pp. 4.
No. 119. Volumetic Estimation of Phosphoric Acid, pp. 21.
No. 120. Cultivation of the Peach Tree, 42 cuts, pp. 31.
No. 121. Hillside Terraces or Ditches, 8 cuts, pp. 5.
No. 122. Types of Tobacco and Their Analyses (Technical), pp. 35.
No. 123. Miscellaneous Agricultural Topics, pp. 10.
No. 128. Pests of Grain Crops, pp. —.
No. 129. Horticultural Experiments at Southern Pines, 1895, pp. 46.
No. 130. Poultry Keeping for Profit, 39 cuts, pp. 53.
No. 132. The Home Vegetable Garden and Its Pests, 8 cuts, pp. 54.
No. 133. Some New Forage Fibre and Other Useful Plants, pp. 2.
No. 136. Fertilizer Analyses of the Fertilizer Control, pp. 34.
No. 137. A Warning in Regard to Compost Peddlers, pp. 8.
No. 138. San Jose Scale in North Carolina, 1 cut, pp. 14.
No. 139. Home Mixed Fertilizers and Composts, pp. 16.
No. 140. Volumetric Estimation of Phosphoric Acid (Technical), pp. 8.
No. 141. A New Tobacco Pest, 2 cuts, pp. 8.
No. 142. Comfortable Low Cost Barns, 12 cuts, pp. 20.
No. 143. Feeding Experiments, Milk Records, etc., pp. 36.
No. 144. Ornithology of North Carolina, pp. 36.
No. 145. Crimson Clover, pp. 20.
No. 146. Miscellaneous Farm Bulletin, pp. 16.
No. 147. A Study of Lettuces, pp. 8.
No. 148. Digestion Experiments, pp. 32.
No. 149. The Apple in North Carolina, pp. 22.
No. 151. The Fertilizer Control for 1897, pp. 12.
No. 152. Poultry Notes, pp. 24.
No. 153. Vinegar Adulteration, pp. 8.
No. 154. The Adulteration of Coffee and Tea, pp. 16.
No. 155. Baking Powders on Sale in North Carolina, pp. 8.
No. 156. The Adulteration of Flour, pp. 12.
No. 157. Mineraline.

Any of the above will be sent cheerfully upon application by Postal Card to the Director of the N. C. Agricultural Experiment Station, Raleigh, N. C.

BULLETIN NO 158 DECEMBER 23 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

THE FERTILIZER CONTROL FOR 1898

A. W. BLAIR.

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M.......................Professor of Chemistry.
F. E. EMERY, M. S.........................Professor of Agriculture.
W. F. MASSEY, C. E.........................Professor of Horticulture
COOPER CURTICE, D. V. S., M. D............Professor of Veterinary Science

EXPERIMENT STATION STAFF.

W. A. WITHERS., A. M, Acting Director and Chemist.

F. E. EMERY, M. S..............................Agriculturist.
W. F. MASSEY, C. E..............................Horticulturist.
COOPER CURTICE, D. V. S., M. D ....Veterinarian.
A. W. BLAIR, A. M ....State Chemist.
C. B. WILLIAMS, M. S..............................Assistant Chemist.
H. K. MILLER, M. S..............................Assistant Chemist.
C. D. HARRIS, B. S..............................Assistant Chemist.
J. A. BIZZELL, B. S..............................Assistant Chemist.
F. G. KELLY..............................Assistant Chemist.
W. G. HAYWOOD, B. LITT..............................Assistant Chemist.
ALEX. RHODES ....Assistant Horticulturist.
C. W. HYAMS..............................Assistant Botanist.
J. M. JOHNSON, M. S..............................Assistant Agriculturist.
B. S. SKINNER..............................Farm Superintendent.
J. M. FIX..............................Secretary.
H. E. KING..............................Chief Clerk.
C. M. HUGHES, B. E..............................Clerk.
MISS M. S. BIRDSONG..............................Stenographer
MRS. L. V. DARBY..............................Stenographer

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

THE FERTILIZER CONTROL FOR 1898.

A. W. BLAIR, State Chemist.

INTRODUCTION.

It was the custom of the Experiment Station, for many years, to publish under its own auspices, the results of the analyses by members of its staff, of the samples of fertilizers taken by the different Inspectors, under the supervision of the Commissioner of Agriculture, from lots on sale in the State.

When the existing agreement was entered into between the Board of Commissioners of the Department of Agriculture and the Board of Control of the Experiment Station, it was made a condition that the Commissioner of Agriculture should have the exclusive publication of the results of the analyses. In consequence, the individual results of the analyses are not included in this bulletin, which it is deemed proper should be published for the information of those interested in the fertilizer industry, either as manufacturers, agents or consumers.

The analytical work was performed from January 1st to July 1st by Messrs. Williams, Miller, Harris, Kelly and Blair, under the immediate direction of the Acting Director of the Station, and for the remainder of the year by Messrs. Williams, Harris, Kelly and Haywood, under the direction of the State Chemist.

Acknowledgment is also made to Commissioner Smith and Secretary Ramsey of the Department of Agriculture for valuable information furnished by them.

PUBLICATIONS CONTAINING FERTILIZER ANALYSES FOR 1898.

The analyses were published as follows:

The Bulletin of the Agricultural Experiment Station of North Carolina, published under the supervision of the Department of Agriculture, for February 1, March 15, March 31, April 15, May 1, May 15, June 1, July 1, November 1, December 1, 1898, and January 1, 1899. The analyses for the spring are published in the Bulletin for July 1st, and for the fall in the Bulletin for January 1, 1899. These may be obtained upon application to the Department of Agriculture.

RELATION OF THE STATION TO THE FERTILIZER CONTROL.

According to the terms of the contract previously referred to, between the Department of Agriculture and the Experiment Station, the Experiment Station has no responsibility for any part of the Fertilizer Control work, except as to the correctness of the analyses of the samples furnished by the Commissioner. These samples are received by the Experiment Station in glass bottles bearing the private seal of the Inspector and having a number by which they are identified. The name of the brand, manufacturer, place at which sample was taken, etc., are withheld from the Experiment Station until the completion of the analysis and the filing of a report of the same with the Commissioner of Agriculture, who then publishes the information in full.

The collecting of samples and publication of results are entirely in the hands of the Commissioner, who is the agent of the Department of Agriculture.

INCREASE OF NUMBER OF BRANDS AND THE DIFFICULTY IN A PROPER CONTROL.

During the year 1890, the last year during which we had a tax for each brand, there were eighty-four brands of commercial fertilizers licensed to be sold in North Carolina. As there was a tax for each brand of $500 per annum, it was always true that a considerable quantity of each brand of fertilizer was sold, or it was hoped by each manufacturer that such would be the case. With a small number of brands, and with large quantities of each brand, it was not difficult to collect samples of each, and to complete analyses of these with promptness.

During the year 1898 there were 823 brands registered, and the Commissioner of Agriculture furnished for analysis samples of 531 brands. During the year 1897 there were 673 brands registered, 336 of which were furnished for analysis. For 1896 there were 366 brands registered, 322 of which were furnished for analysis, and in 1895 there were 541 brands registered, 275 of which were furnished for analysis.

For the three years, 1895-97 inclusive, therefore, samples of only about fifty per cent. of the licensed brands were analyzed, while in 1898 samples of about 65 per cent. of the registered brands were analyzed. The total number of fertilizers analyzed during 1898, including duplicate samples of brands, was 593, and many of these were worked two and three times.

It is impossible for us to say whether the brands which were not sampled were actually on sale in the State. As there is no limit to the number of brands, it is quite possible that, in order to meet the varied demands which may be made by the possible consumers, many brands are registered of which there is no sale.

TABLE NO. 1.—FIRMS WHICH REGISTERED BRANDS FOR SALE IN NORTH CAROLINA DURING 1898.

NAME.	ADDRESS.	Superphosphates.	Superphosphates with Potash.	Ammoniated Superphosphates.	Ammoniat'd Sup'phosphates with Potash.	Miscellaneous.	Total.
Acme Manufacturing Co.	Wilmington, N. C	1	...	...	4	1	6
American Fertilizing Co.	Norfolk, Va.	...	1	1	7	6	15
Armour Fertilizing Works	Chicago, Ill	...	...	2	9	...	11
Armour Packing Co.	Kansas City, Mo	...	...	4	6	3	13
Arps, Geo. L. & Co	Norfolk, Va	...	...	...	1	...	1
Ashepoo Fertilizer Co.	Charleston, S. C.	8	1	...	6	2	17
Atlantic Chemical Co	Norfolk, Va.	5	1	...	7	...	13
Baltimore Guano Co.	Baltimore, Md	1	...	...	5	1	7
Baltimore Pulverizing Co	Baltimore, Md	...	...	...	4	...	4
Banister Dan Mills Co	Houston, Va	...	...	...	...	1	1
Baugh & Sons Co.	Norfolk, Va., Philadelphia and Baltimore	1	...	5	11	5	22
Beam, J. H.	Wilmington, N. C.	1	1	...	2	...	4
Bell, Westbrook & Jurney	Beaufort, N. C.	...	...	...	...	1	1
Berkley Chemical Co	Charleston, S. C.	4	4	...	4	...	12
Best & Thompson	Goldsboro, N. C.	...	...	...	...	1	1
Bonday, James Jr., & Co.	Baltimore, Md	...	...	...	...	4	4
Boykin & Stanly	Baltimore, Md	...	...	1	2	2	5
Bradley Fertilizer Co	Boston, Mass.	1	...	...	2	...	3
Bragaw, Wm. & Co	Washington, N. C.	...	...	...	1	1	2
Branch, A. P.	Wilson, N. C.	...	...	...	2	...	2
Buxton & Baugham	Rich Square, N. C	...	...	...	1	...	1
Calder Bros.	Wilmington, N. C	...	...	...	...	1	1
Caraleigh Phosphate and Fertilizer Works	Raleigh, N. C	3	2	...	5	3	13
Charlotte Oil and Fertilizer Co.	Charlotte, N. C	4	2	...	13	1	20
Chemical Co. of Canton	Baltimore, Md.	1	1	...	3	...	5
Chicora Fertilizer Co	Charleston, S. C.	8	5	...	5	1	19
Columbia Guano Co.	Norfolk, Va.	5	1	...	9	1	16
Darlington Phosphate Co	Darlington, S. C	3	1	...	4	1	9
Detrick Fertilizer and Chemical Co	Baltimore, Md	2	1	...	7	1	11
Dey & Bro	Beaufort, N. C.	...	...		...	1	1
Edisto Phosphate Co.	Charleston, S. C	4	2	...	3	1	10
Etiwan Phosphate Works	Charleston, S. C	5	5	...	5	1	16
Fowler Cowell & Co.	Bayboro, N. C.	...	...	...	3		3
Garrell, J. F. & Co.	Wilmington, N. C.	...	...	1	11	1	13
Goldsboro Oil Co.	Goldsboro, N. C.	...	...	...	3	...	3
Great Eastern Fertilizer Co.	New York, N. Y	...	...	...	4	...	4
Greenville Fertilizer Co	Greenville, S. C.	1	1	...	2	...	4
Criffith & Boyd	Baltimore, Md	...	...	...	3	2	5
Hadley, J. C. & Co	Wilson, N. C.	...	...	...	1	...	1
Harrell, S. B. & Co	Norfolk, Va.	...	...	...	1		1
Hines, E. J. & Sons	Salem, N. C.	...	...	...		1	1
Holmes & Dawson.	Norfolk, Va.	...	...		1	...	1
Holmes, Wm. H.	New York, N. Y.	...	...	...	1	...	1
Hubbard, M. P. & Co.	Baltimore, Md	...	...	...	1	...	1

TABLE NO. 1.—FIRMS WHICH REGISTERED BRANDS FOR SALE IN NORTH CAROLINA DURING 1898.—Continued.

NAME.	ADDRESS.	Superphosphates.	Superphosphates with Potash.	Ammoniated Superphosphates.	Ammoniat'd Sup'phosphates with Potash.	Miscellaneous.	Total.
Idol, W. H. & Co.	Deep River, N. C.					1	1
Imperial Fertilizer Co.	Charleston, S. C.	3	6		5	1	15
Imperial Co.	Norfolk, Va.	1			7	3	11
Jamestown Bone Meal Co.	Jamestown, N. C.					1	1
Lazaretto Guano Co.	Baltimore, Md.	1	1		13	1	16
Lee, A. S. & Son.	Richmond, Va.		3			1	4
Lister's Agricultural Chemical Works	Newark, N. J.				5		5
MacMurphy, W. C. & Co.	Charleston, S. C.	1			10	4	15
Mape's Formula and Peruvian Guano Co.	New York, N. Y.				6		6
Marlboro Mill Co.	Gibson, N. C.					1	1
Meadows, E. H. & J. A. Co.	Newbern, N. C.	1	1		8	2	12
Monumental Chemical Co., of Baltimore City	Baltimore, Md.				2		2
Navassa Guano Co.	Wilmington, N. C.	3	10		20	3	36
Norfolk Fertilizing Co.	Norfolk, Va.				9		9
North Carolina Cotton Oil Co	Raleigh, N. C.				1		1
Norwood, G. A., Jr.	Goldsboro, N. C.					1	1
Ober, G., Sons & Co	Baltimore, Md.	1	1		5		7
Pacific Guano Co.	Boston, Mass., and Charleston, S. C.	1			1		2
Patapsco Guano Co.	Baltimore, Md.	1			6		7
Piedmont-Mt. Airy Guano Co	Baltimore, Md.		1		9		10
Pocahontas Guano Co.	Lynchburg, Va.		1		4		5
Pocomoke Guano Co.	Norfolk, Va.	1	1		7	4	13
Powell Fertilizer and Chemical Co.	Baltimore, Md.	1	1		3		5
Powers, Gibbs & Co.	Wilmington, N. C.	12	8		30	6	56
Quinnipiac Co., The	New York, N. Y.				1		1
Ragsdale & Smith	Jamestown, N. C.					1	1
Rasin Fertilizer Co.	Baltimore, Md.	1	1		4		6
Reese, John S. & Co.	Baltimore, Md.	1			3		4
Reese Manufacturing Co.	Norfolk, Va.			1			1
Reidsville Fertilizer Co.	Reidsville, N. C.	1			5		6
Richmond Guano Co	Richmond, Va.	4	1		6	1	12
Royster, F. S., Guano Co	Norfolk, Va. and Tarboro, N. C.	4	3		9	2	18
Slingluff & Co	Baltimore, Md.				1		1
Southern Chemical Co	Winston, N. C.	7	5		7		19
Standard Fertilizer M'f'g Co.	Charleston, S. C.	5	6		7	1	19
Stono Phosphate Works.	Charleston, S. C.	2	1		3	1	7
Sweet, R. N	Wilmington, N. C.					1	1
Swift & Co.	Chicago, Ill.					1	1
Virginia-Carolina Chemical Co.	Richmond, Va.	34	19	2	95	1	51
Vann, S. C.,	Franklinton, N. C.				1		1
Wagener, F. W. & Co.	Charleston, S. C.	1	1		2	1	15

TABLE NO. 1.—FIRMS WHICH REGISTERED BRANDS FOR SALE IN NORTH CAROLINA DURING 1898.—Continued.

NAME.	ADERESS.	Superphosphates.	Superphosphates with Potash.	Ammoniated Superphosphates.	Ammoniat'd Sup'phosphates with Potash.	Miscellaneous.	Total.
Weil, H. & Bro.	Goldsboro, N. C.	...	..	...	..	2	2
Wooldridge, Robt. A. Co. . . .	Baltimore, Md.	....	....	....	4	....	4
Walker, Joshua	Baltimore, Md.	1	..	....	1		2
Ward, S. H. & Sons	Jamestown, N. C	...	..	..	..	1	1
Wariner, W. H. & Co.	Ruffin, N. C.	....	....	..	1	....	1
Wood, T. W. & Sons	Richmond, Va.	...	1	1	6	..	8
Young, E. F.	Dunn, N. C.	.	....		1	..	1
Zell Guano Co., The	Baltimore, Md	1	...	...	3	1	5
Total	. . . .	147	101	18	470	87	823

EXTENT AND DISTRIBUTION OF THE TRADE.

The number of brands on sale in the State during the year 1898 was greater than for the year 1897, or for any previous year. The accompanying table shows the number of brands licensed each year for the past fourteen years:

TABLE NO. 2.

	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898
Acid ph'phates or simple superphosphates	9	11	10	9	12	16	59	81	86	86	150	107	116	147
Superphosphates with potash.	10	9	8	7	5	4	13	24	22	24	36	68	69	101
Ammoniated superphosphates with potash . . .	63	66	58	62	62	63	178	232	264	284	330	398	388	470
Ammoniated superphosphates.	...	....	....	....	....	....	15	12	5	12	11	12	17	18
Kainit.	....	..	..	....	..	....	19	25	29	35	38	34	33	37
Other potash salts and chemicals..	..	..	...	...	..	...	3	4	6	6	4	13	10	25
Animal bone. .	....	..	..	....	....	....	....	....	3	3	9	16	12	10
Fish scrap	.	....	....	..	..	..	4	5	4	2	4	8	4	5
Miscellaneous	3	4	1	1	2	1	4	6	8	10	4	10	24	10
Totals.	85	90	77	79	81	84	295	389	427	462	541	666	673	823

Attention has been called in previous Reports to the fact that since 1891 we have had a tonnage tax instead of a brand tax. This change in the law has doubtless had the effect of increasing the number of brands very largely. It is to be noted also that there has been an increase in the amount of commercial fertilizers consumed in the State.

The Department estimates that during 1898 about 246,000 tons of commercial fertilizers were sold to parties in North Carolina. This estimate is based on the number of tags sold for the year. From this should be subtracted the number of tons corresponding to the unused tags in the hands of the manufacturer at the end of the year, and to this estimate should be added the number of tags corresponding to the tags purchased in former years and used during 1898—together with the tons illegally sold without tags attached. These three items are probably small—at any rate we have no means of estimatiag them. The estimate for the year 1897 was 208,000 tons, for 1896 187,000, for 1895 about 111,000, and for 1894 about 131,000 tons.

For the past seven years the number of brands has increased each year over the previous year as follows:

In the year 1892, increase over the previous year, 101.
In the year 1893, increase over the previous year, 29.
In the year 1894, increase over the previous year, 36.
In the year 1895, increase over the previous year, 80.
In the year 1896, increase over the previous year, 125.
In the year 1897, increase over the previous year, 7.
In the year 1898, increase over the previous year, 150.

The number of brands accredited to the several States is shown in the following table:

TABLE NO. 3.

	1885	1886	1887	1888	1889	1890	1892	1893	1894	1895	1896	1897	1898
Massachusetts	3	1	4	7	2	2	3	3	3	3	3	3	3
Connecticut	3	1	2	1	1	1	....	....	....	....	....	....	....
New York	4	3	1	1	2	1	8	10	8	7	9	11	12
New Jersey	2	3	2	4	4	5	3	7	2	2	1	2	5
Delaware	4	4	4	3	3	3		5	6	2	....	....	....
Maryland	31	35	29	25	28	25	98	104	93	88	100	94	111
Pennsylvania	....	1	....	1	....	....	5	12	7	6	....	....	....
Virginia	18	21	14	12	12	16	96	106	146	189	213	214	302
North Carolina	9	10	11	13	14	18	78	89	98	137	166	186	215
South Carolina	11	11	10	13	15	13	85	82	97	96	153	138	150
Georgia	....	....	....	....	....	....	13	7	1	....	....	....	....
Missouri	....	....	....	....	....	....	....	....	1	11	11	13	13
Illinois	....	....	....	....	....	....	....	....	....	....	10	12	12
Totals	85	90	77	79	81	84	389	427	462	541	666	673	823

Assuming that there is a close relation between the number of brands manufactured in each State and the number of tons of fertilizers sold by each State, the table furnishes an interesting basis of comparison as to what extent the trade of manufacturing is distributed amomg the several States.

We have calculated the distribution of the trade for 1897 and 1898 among the different States upon the basis of the tags sold, and have given the calculations upon the different bases for comparison. We insert in the following tables also some other comparative figures for 1897 and 1898.

TABLE NO. 4—1897.

STATE.	No. of Tons Taxed.		No. of Brands.		No. of Firms.		Average No. of Brands Per Firm.	Average No. of Tons Per Firm.	Average No. of Tons Per Brand.
	Number.	Per Cent. of Total.	Number.	Per cent. of Total.	Number.	Per Cent. of Total.			
Illinois	200.0	.1	12.	1.79	1.	1.15	12.	200.	16.6
Maryland	13482.8	6.4	94.	13.97	20.	23.00	4.7	674.1	143.4
Massachusetts	0.	......	3.	.44	1.	1.15	3.	......	......
Missouri	39.	......	13.	1.93	1.	1.15	13.	39.	3.
New Jersey	2300.	1.1	2.	.30	1.	1.15	2.	2300.	1150.
New York	50.	......	11.	1.63	3.	3.44	3.6	16.6	4.5
North Carolina	87824.2	42.2	186.	27.64	30.	34.48	6.2	2927.4	472.1
South Carolina	12809.	6.2	138.	20.50	14.	16.09	9.9	914.9	92.8
Virginia	91461.2	44.	214.	31.80	16.	18.39	13.3	5716.3	427.3
	208166.2	100.00	673.	100.00	87.	100 00	7.7	2392.7	309.3

TABLE NO. 5—1898.

STATE.	No. of Tons Taxed.		No. of Brands.		No. of Firms.		Average No. of Brands Per Firm.	Average No. of Tons Per Firm.	Average No. of Tons Per Brand.
	Number.	Per Cent. of Total.	Number.	Per Cent. of Total.	Number.	Per Cent. of Total.			
Illinois	200.	.08	12.	1.46	2.	2.15	6.	100.	16.6
Maryland	12366.8	5.03	111.	13.48	20.	21.51	5.5	618.3	111.4
Massachusetts	1550.	.63	3.	.36	1.	1.07	3.	1550.	516.6
Missouri	100.	.04	13.	1.58	1.	1.07	13.	100.	7.7
New Jersey	1725.	.70	5.	.61	1.	1.07	5.	1725.	345.
New York	525.	.21	12.	1.46	4.	4.30	3.	131.	43.7
North Carolina	78446.6	31.89	215.	26.12	33.	35 50	6.5	2377.2	364.8
South Carolina	15415.	6.27	150.	18.23	13.	13.98	11.5	1185.8	102.8
Virginia	135645.3	55.15	302.	36.70	18.	19.35	16.8	7535.8	449.1
	245973.7	100.00	823.	100.00	93.	100.00	8.85	2644.8	298.9

VALUATION OF FERTILIZERS AND HOW THEY ARE DETERMINED.

The valuation of the three constituents—available phosphoric acid, ammonia and potash—are intended to give the market price for cash at the seaboard of the ingredients making up the fertilizer. The cash prices for small lots in bags, free on board cars, are intended. These valuations are made up early in January of each year, to run through the spring and fall seasons. It is expected that there will be variations in the market price of the ingredients during the year, but this variation usually is not great. This is because fertilizing materials are largely contracted for in advance, before the opening of the year, and in most cases the ingredients have already been wholly purchased and the fertilizers already maniputated before the beginning of the season.

The valuations of the constituents are fixed by careful examinations of existing trade conditions, the markets at important centres, and from actual quotations given by seaboard manufacturers and dealers upon various ingredients used for manipulating fertilizers. These quotations are for cash in small lots, free on board and bagged.

The relative commercial valuation given to the three valuable ingredients for 1897 and 1898 was:

For available phosphoric acid	4 cents per pound.
For ammonia	12 cents per pound.
For potash	5 cents per pound.

These figures were based, as usual, on the actual retail cash price of the unmixed ingredients at the seaboard in bags.

From the commercial valuation of a fertilizer, a farmer, by using these figures, can see the actual cash worth at the seaboard of the unmixed ingredients used in the fertilizer. In other words, with cash in hand, he could purchase from seaboard manufacturers the materials used to make up the fertilizer at the valuation given per ton. For interior points freight, of course, must be added. In the bulletins showing the analyses of fertilizers a table, giving the various freight rates from seaboard to interior points, is inserted for the convenience of buyers.

SELLING PRICE AND VALUATIONS.

It must be remembered, however, that the Station's valuation of a brand of fertilizer does not represent the proper selling price at the point of consumption, since it does not include the freight, cost of manufacture, storage, commission, etc. It often happens that consumers lay too much stress upon "valuation" and too little

upon the analysis. There is not necessarily any direct relation between the valuation and the comparative profits that may result from the use of the various brands. The adaptation of the goods to a particular crop on which it is to be used and the requirements of the soil which is to be treated, are subjects which should be carefully studied.

There is a large class of fertilizers on the market which are often sold at low prices, but are at the same time very expensive. They are sold at low prices because they contain small amounts of fertilizing constituents in the form of low grade materials, although they are too often sold under the flattering name of high-grade goods.

In general, cheap fertilizers are less economical than more expensive ones, since it costs just as much to mix, bag and ship a ton of material furnishing fifty pounds of plant food (phosphoric acid, ammonia and potash), as it does a ton of material furnishing five hundred pounds of these constituents.

In buying a fertilizer, two things especially should be taken into consideration:

1. Is the firm one of good reputation and standing?

2. Do the goods contain what the soil and crop require, and in the proper proportions?

HOW VALUES PER TON ARE CALCULATED.

It may be of interest to some to know how values per ton are calculated, using the valuations for the constituents just given. The guaranteed percentages of these constituents present in the fertilizers are given. These represent parts per 100. These percentages are accordingly multiylied by the valuation per pound to get the value per 100 pounds of the fertilizer. This is multiplied by twenty to determine the value per ton (2,000 pounds). This is done for all three constituents, and the three amounts are added together to arrive at the cost value of the unmixed ingredients per ton at the seaboard.

The following is an example:

Percentage or pounds per 100.	Per 100 lbs.	Per ton 2,000 lbs.
8 Available phosphoric acid at 4 cents per lb	$0.32	$6.40
2 Ammonia at 12 cents per lb.	.24	4.80
2 Potash and 5 cents per lb.	.10	2.00
Total value	$0.66	$13.20

The valne per ton as here given represents the market price per ton at the seaboard of the unmixed ingredients. For interior points railroad rates to those points must be added.

TERMS EXPLAINED.

The three valuable constituents which are found in fertilizing materials are available phosphoric acid, nitrogen (or ammonia) and potash. Available phosphoric acid is the sum of the water soluble and citrate soluble (or as it is sometimes called, the reverted or precipitated) phosphoric acid. The term available phosphoric acid is also intended to represent that part of the total phosphoric acid which is readily available as plant food, though it is impossible to determine absolutely just how much is thus available, on account of the great variety of crops and the varying soil conditions. Phosphoric acid, represented by the symbols P_2O_5, never occurs free, but is always in combination with other materials.

Nitrogen (or ammonia, symbol $N\ H_3$), is the most expensive plant food, and in the form of nitrates or ammonia salts, is soluble in water, and therefore readily available as plant food. It may also exist in organic material, such as dried blood, and be equally valuable.

Potash (symbol, K_2O), is also found combined and exists in a number of forms, chief of which are the potash salts which come from Stassfurt, Germany.

Although these constituents are never found free, at least in fertilizers, yet, on account of the forms of combination it has been found very convenient to refer to them, and not to the compounds which contain them.

Superphosphates or acid phosphates are prepared by grinding the natural phosphate rocks, and treating the product with sulphuric acid, which converts the greater part of the phosphoric acid into the soluble or available form.

A complete fertilizer is one which contains the three essential constituents, namely, phosphoric acid, nitrogen (or ammonia) and potash.

TABLE NO. 6—AVERAGE PERCENTAGE COMPOSITION OF FERTILIZERS ON SALE IN NORTH CAROLINA FOR SEVERAL YEARS.

Kind of Fertilizer.	Year.	Available Phosphoric Acid.		Ammonia.		Potash.		Relative Seaboard Value per ton of unmixed ingredients.	
		By Analysis.	By Guarantee.	By Analysis.	By Guarantee.	By Analysis.	By Guarantee.	By Analysis.	By Guarantee.
Acid phosphates....	1890	12.92	12.25	......	......	......	......	$10 34	$ 9.80
	1891	12.21	12.06	......	......	......	......	9.77	9.65
	1892	12.25	12.01	......	......	......	......	9.80	9.61
	1893	12.93	12.04	......	......	......	......	10.34	9.63
	1894	13.73	12 00	......	......	......	......	10.98	9.60
	1895	13.29	12.21	......	......	......	......	10.63	9.77
	1896	13.25	11.95	......	......	......	......	10.60	9.56
	1897	12.96	12.15	......	......	......	......	10.37	9 72
	1898	13.17	12.30	......	......	......	......	10.62	9.85
Acid phosphates with potash.	1890	12.04	10.90	......	......	1.77	1.42	11.40	10.14
	1891	11.17	10.29	......	......	1.66	1 50	10.60	9 73
	1892	11 22	9 97	......	......	2.06	1.53	11.04	9.51
	1893	10.38	9.60	......	......	1.78	1.40	10.08	9.08
	1894	11.27	9.77	......	......	1.77	1.47	10.79	9.29
	1895	10.78	9.32	......	......	2.02	1.93	10.64	9.39
	1896	10.47	9.26	......	......	2.01	1.91	10 39	9.32
	1897	10.58	9.66	......	......	1.89	1.85	10.35	9.58
	1898	10.74	9.74	......	......	2.16	2.03	10.74	9.52
Ammoniated superphates with potash.	1890	9.11	8.53	2.41	2.29	2 02	1.71	15.09	14.03
	1891	8.11	8.24	2.59	2.51	2.20	1.88	14.90	14.50
	1892	8.70	8.10	2.63	2 46	2.65	2.12	15.92	14.50
	1893	8 37	8 05	2.59	2.47	2.56	1.97	15.47	14.34
	1894	9.04	8.06	2.85	2.76	2.51	2.21	16.58	15.28
	1895	8.84	7.78	3.26	3.05	2.91	2.45	17.81	15.99
	1896	8.99	8.05	2.99	2.76	2.68	2.33	17.05	15.39
	1897	9.01	8.01	2.85	2.56	2.43	2.13	16.47	14.67
	1898	8.69	7.97	2.90	2.58	2.58	2.25	16 63	14.86

The accompanying tables show the number of brands of each of the three different kinds of fertilizers which fell below their guarantee during 1897 and 1898.

TABLE NO. 7—1897.

Number.	Kind of Fertilizer.	Found Below Guarantee in: Available Phosphoric Acid. No.	Available Phosphoric Acid. Per. Ct.	Ammonia. No.	Ammonia. Per. Ct.	Potash. No.	Potash. Per. Ct.	Total. No.	Total. Per. Ct.	Valuation. No.	Valuation. Per. Ct.
75	Acid Phosphates....................	15	20	..	....	..	.....	15	20	15	20
31	Superphosphates with Potash.......	4	12.9	..	...	9	29	13	41.9	3	9.7
202	Ammoniated Superphosphates with Potash.	10	5	22	10.9	27	13.4	59	29.2	3	1.6
308	Total...........................	29	9.4	22	10.9	36	15.5	87	28.2	21	6.8

TABLE NO. 8—1898.

Number.	Kind of Fertilizer.	Found Below Guarantee in: Available Phosphoric Acid. No.	Available Phosphoric Acid. Per Ct.	Ammonia. No.	Ammonia. Per Ct.	Potash. No.	Potash. Per Ct.	Total. No.	Total. Per Ct.	Valuation. No.	Valuation. Per Ct.
141	Acid Phosphates.........................	15	10.6	...	......	...	......	15	10.6	15	10.6
68	Superphosphates with Potash.......	9	13.2	...	......	15	22 0	24	35.3	5	7.4
341	Ammoniated Superphosph'ts with Potash.	37	10 8	29	8.5	33	9.7	99	29.0	11	3.2
*43	Miscellaneous	1	2.3	2	4.6	...	0.0	3	7.0	1	2.3
593	Total......................................	62	11.2	31	8.6	48	11.0	141	23.8	32	5.4

* Of the miscellaneous fertilizers, 25 contained potash alone, 11 ammonia alone, 5 phosphoric acid and ammonia, and 2 ammonia and potash.

Of the acid phosphates for 1898, one brand in every nine and two-fifths fell below guarantee in available phosphoric acid and valuation.

Of the superphosphates with potash, one brand in every seven and one-half fell below guarantee in available phosphoric acid; one in every four and one-half in potash; one in nearly every three in available phosphoric acid and potash, and one in every thirteen and three-fifths in valuation.

Of the so-called complete fertilizers, one in every nine and a

fraction fell below guarantee in available phosphoric acid; one in nearly every twelve in ammonia; one in every ten and one-third in potash; one in about three and one-half in either available phosphoric acid, ammonia or potash, and one in every thirty-one in valuation.

Of the miscellaneous brands, one in every forty-three fell below its guarantee in available phosphoric acid; one in every twenty-two in ammonia; none in potash; one in every fifteen in either available phosphoric acid, or ammonia, and one in forty-three in valuation.

Or, if we take the average of the whole, it was found that one fertilizer out of about every four and one-fifth fell below its guarantee in some ingredient; one in every nine in phosphoric acid; one in every eleven and three-fifths in ammonia; one every nine in potash, and one in about eighteen and one-half in valuation.

GENERAL CONCLUSIONS.

(1) The number of brands registered for sale in North Carolina during 1898 exceeded by 150 the registration for 1897, which was the highest up to that time, and also shows a greater increase than in any previous year. This rapid increase has been noticeable since 1890, when there was a change from the brand tax to the tonnage tax.

(2) The consumption of commercial fertilizers has increased very rapidly each year, amounting to about 246,000 tons in 1898, valued at nearly six million dollars, as against 208,000 tons during 1897, valued at about five million dollars.

(3) The larger part of the fertilizers now used in the State are manufactured in North Carolina and Virginia.

(4) The average percentage composition of commercial fertilizers for 1898 is slightly above that for 1897, with the exception of available phosphoric acid in complete fertilizers, and this falling off is probably due to an interpretation of the law which allows a fertilizer high in ammonia and potash to fall below eight per cent. in available phosphoric acid.

(5) One out of every four and one-fifth of the whole number of fertilizers analyzed fell below its guarantee in some ingredient, and one out of eighteen and one-half in valuation.

(6) The number of firms having brands registered in North Carolina in 1898 is an increase of about seven per cent. over the number in 1897.

(7) During the year 1898 there were 823 brands of fertilizers registered in the State, and the Commissioner of Agriculture furnished for analysis samples of 531 of these brands. This is an increase of about 15 per cent. over 1897. The total number

analyzed during 1898, including duplicate samples of brands, was 593.

(8) There is no method for determining the value of a commercial fertilizer (except by actual field trial) other than by chemical analysis, and but for the Fertilizer Control the farmers of the State would be greatly imposed upon by worthless goods.

BULLETIN No. 159 DECEMBER 24, 1898

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

Horticultural Experiments AT Southern Pines, 1896.

REPRINTED FROM THE SECOND ANNUAL REPORT OF THE SUPERVISING COMMITTEE OF THE EXPERIMENTAL FARM OF THE N. C. STATE HORTICULTURAL SOCIETY.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M .... Professor of Chemistry.
F. E. EMERY, M. S .... Professor of Agriculture.
W. F. MASSEY, C. E .... Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D .... Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.

F. E. EMERY, M. S .... Agriculturist.
W. F. MASSEY, C. E .... Horticulturist.
COOPER CURTICE, D. V. S., M. D .... Veterinarian.
A. W. BLAIR, A. M .... State Chemist.
C. B. WILLIAMS, M. S .... Assistant Chemist.
H. K. MILLER, M. S .... Assistant Chemist.
C. D. HARRIS, B. S .... Assistant Chemist.
J. A. BIZZELL, B. S .... Assistant Chemist.
F. G. KELLY .... Assistant Chemist.
W. G. HAYWOOD, B. LITT .... Assistant Chemist.
ALEX. RHODES .... Assistant Horticulturist.
C. W. HYAMS .... Assistant Botanist.
J. M. JOHNSON, M. S .... Assistant Agriculturist.
B. S. SKINNER .... Farm Superintendent.
J. M. FIX .... Secretary.
H. E KING .... Chief Clerk.
C. M. HUGHES, B. E .... Clerk.
MISS M. S. BIRDSONG .... Stenographer.
MRS. L. V. DARBY .... Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

PREFACE.

The Experimental Farm at Southern Pines has been conducted by a Supervising Committee composed of the representatives of the State Horticultural Society, the German Kali Works and the North Carolina Agricultural Experiment Station.

The purposes for which the farm was organized have been set forth in previous reports as well as in the accompanying one. On account of the connection of the Experiment Station with the work it was deemed advisable to reprint the report for 1895 as one of its bulletins (No. 129). For the same reason the accompanying report for 1896 is reprinted as a station bulletin—said publication being made with the permission of the supervising committee.

The report is somewhat delayed but this will not diminish its value as a record of the progress of the work.

On October 31, 1898, the Experiment Station, by order of the Board of Trustees, withdrew from the management of the farm, and in consequence assumes no responsibility and claims no credit for the management and publications since that date.

W. A. Withers,
Acting Director.

SUPERVISING COMMITTEE FOR 1897.

W. A. WITHERS, A. M., *Chairman.*
Acting Director, N. C. Experiment Station.

W. F. MASSEY, C. E., *Horticulturist.*
Horticulturist, N. C. Experiment Station.

THOMAS L. BROWN, *Secretary.*
Secretary, N. C. State Horticultural Society.

J. VAN LINDLEY, *President.* P. H. BECK.
N. C. State Horticultural Society.

B. VON HERFF, PH. D.
Representing German Kali Works.

EXPERIMENTAL FARM OF THE NORTH CAROLINA STATE HORTICULTURAL SOCIETY: SOUTHERN PINES, N. C.

The Supervising Committee takes pleasure in presenting this, the Second Annual Report of the operations of the North Carolina State Horticultural Society's Experimental Farm at Southern Pines, N. C. For a full description of the organization of this Farm and the preparatory work connected therewith, the reader is referred to the First Annual Report for 1895.

It may here be stated that, from the very beginning the work at the Experimental Farm has been done in the most careful, exact and thorough manner. It may be well also to call attention to the fact that the experiments now under way at the Experimental Farm are conducted on a more extensive scale than any yet attempted in this country. As a matter of fact the experiments are confined to the study of plant food and their effects on various fruit and vegetable crops.

For very good reasons the work of the Experimental Farm has been limited to a comparatively few objects. In this way better results can be obtained than by trying to cover a great number of things.

It is not practicable on the majority of farms to have farmyard manure in sufficient quantities to supply all the needs of the different crops. The result is that commercial fertilizers must be used.

Briefly stated, the principal object is to determine by series of actual experiments on the farm the best quantities and relative proportions for using the various fertilizing substances, in order to produce the largest crops at the least expense. Connected with these experiments is the study of methods for resisting and treating the attacks of fungus diseases and of insects, and also the adaptability of the different varieties of fruits and vegetables to climatic conditions, etc. It is confidently expected that the results from this important work at the Experimental Farm will be of special value to fruit and vegetable growers everywhere in the United States. In a few years the results of these careful experiments at the farm should show the safest and most economical way for chemical fertilizers to be used, so that the time, labor and money of the farmer shall be wisely and properly expended in buying and using fertilizing materials adapted to the wants of his soil and his crops.

THE LOCATION OF THE EXPERIMENTAL FARM.

The Experimental Farm is situated near the village of Southern Pines in Moore County, North Carolina, some sixty-six miles southwest from Raleigh, on the Seaboard Air Line. This location was selected for many good reasons, but principally on account of the fine climate and soil both most favorable for experiments. The soil has proved to be well adapted to the growth of grapes, peaches and other fruits, and within a few years the region around Southern Pines has become quite an important fruit-growing district. The land is level and uniform, and thus well suited for the extensive scheme of field experiments conducted by the Society.

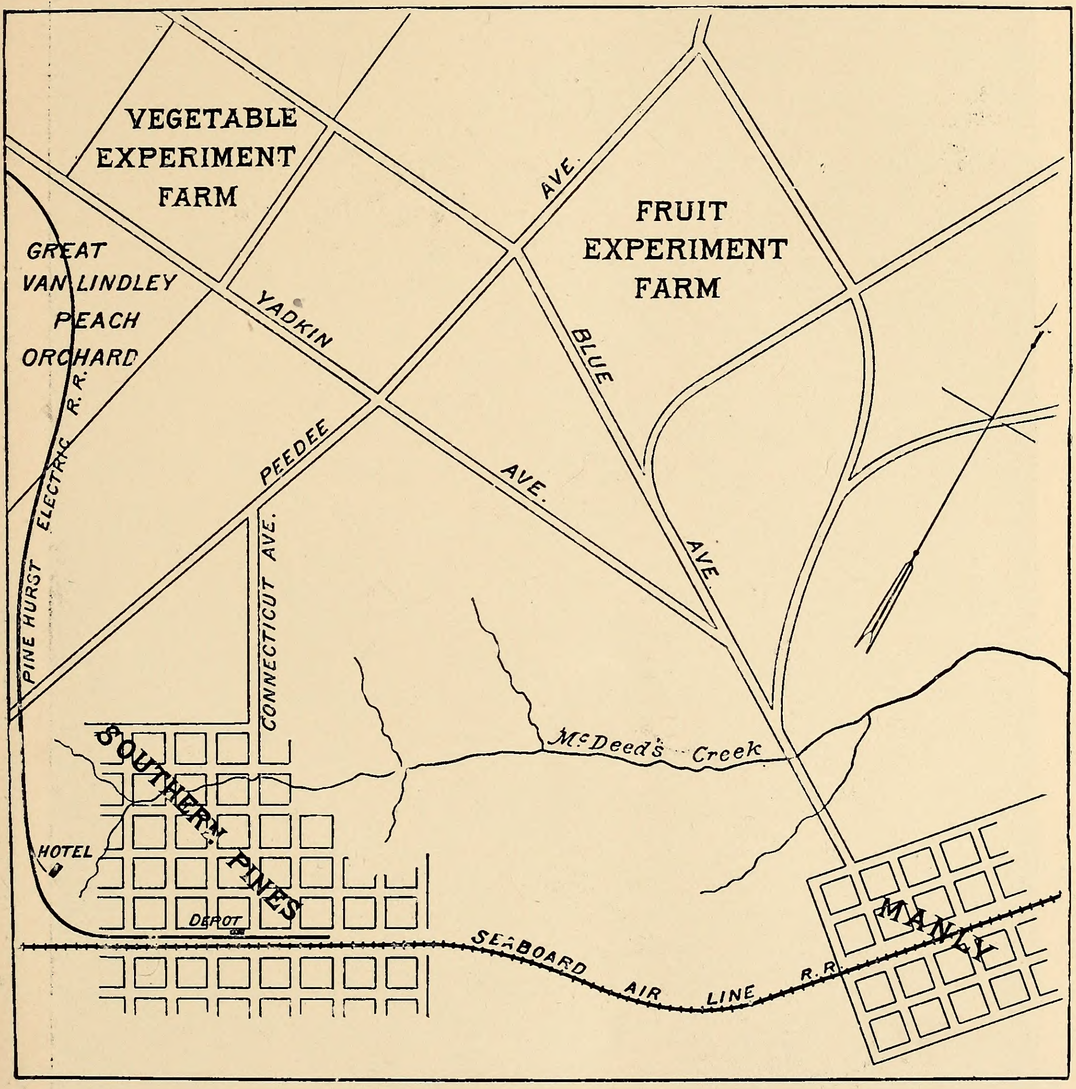
The soil represents large tracts of land originally in long-leaf pine, but now partially covered with a growth of smaller pines, oaks and dogwood. The long-leaf pine district as may be known, extends from the Southern Virginia along the Atlantic coast to Florida, along Gulf of Mexico and through Georgia to Texas. Thus the lands of the Experimental Farm practically represent more or less the same kind of soil found in this great long-leaf pine region.

Two series of investigations are now being conducted on the Experimental Farm:—one series being devoted to vegetables and field crops and the other to fruits. The location chosen for the fruit experiments lies immediately north of the town of Southern Pines, (Fig. 2), and about one mile from its corporate limits. The location furnishes a body of land sixty-five acres in extent with a very slight slope to the northeast. The vegetable farm consists of a tract of fifteen acres, about one-fourth of a mile to the southwest of the fruit farm. The vegetable farm was not ready for experimental work in 1895. A full account of the breaking of the land and its preparation for cultivation will be found in the First Annual Report.

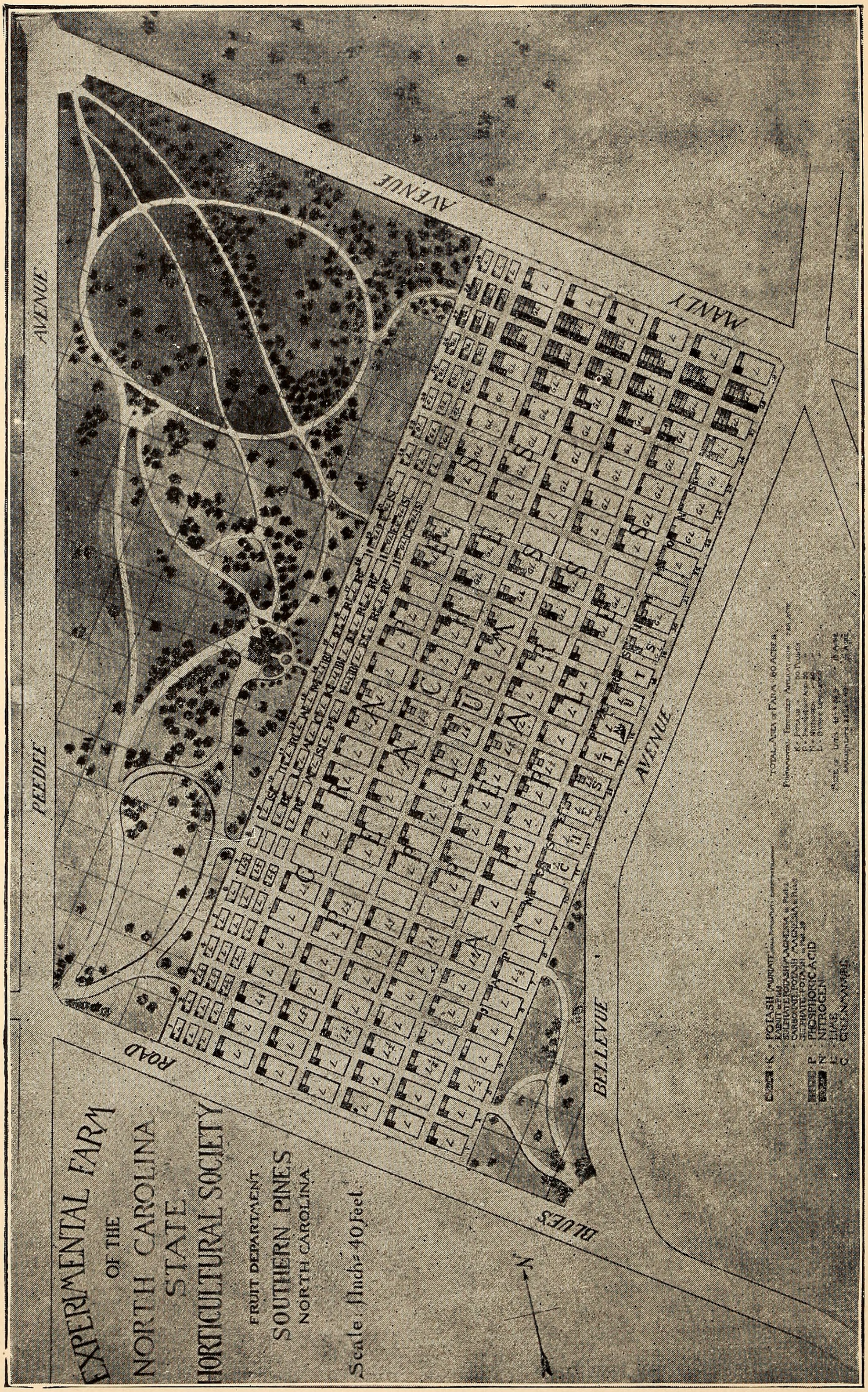
THE ORGANIZATION OF THE EXPERIMENTAL FARM.

The North Carolina Horticultural Society sought and obtained the active cooperation of the North Carolina Agricultural Experiment Station at Raleigh. This Station has furnished the expert work relating to horticultural, botanical, entomological, and chemical subjects, while the German Kali Works contributes to the fund formed by the Society to carry on this work, and a representative of the Works is assigned a position on the Supervising Committee.

A summary of the articles of agreement adopted by the parties cooperating in conducting the experimental work, is given herewith. The object of the work as has been stated, is to determine the proportion of the different fertilizing ingredients necessary for the best growth and development of orchard and garden fruits and other horticultural and agricultural products, and the best treatment of the



Map showing location of Experimental Farms of the N. C. State Horticultural Society, Southern Pines, N. C.



Showing Fruit Department, Experimental Farm, Southern Pines, N. C.

soil to produce this result. No commercial brand of fertilizers is used, but fertilizing ingredients are employed in various combinations.

The locality of the work is known as "The Experimental Farm of the North Carolina State Horticultural Society." Reports of progress are published annually, or oftener if necessary, and these reports can be republished, either in whole or in part, by either of the institutions.

The entire conduct of the work is entrusted to a Supervising Committee composed of six members, of which three are appointed by the Horticultural Society, two by the Experiment Station, and one by the German Kali Works. The Committee for the year 1896, was:—

On behalf of the Horticultural Society:

J. Van Lindley, President N. C. State Horticultural Society.

C. D. Tarbell, Member Executive Committee of the Society.

Gerald McCarthy, Secretary of the Society.

On behalf of the Experiment Station:

H B. Battle, Director N. C. Agricultural Experiment Station.

W. F. Massey, Horticulturist of the Station.

On behalf of the German Kali Works:

B. von Herff, New York.

The Supervising Committee has been organized as follows:

H. B. Battle, Chairman.

Gerald McCarthy, Secretary.

C. D. Tarbell, member resident at Southern Pines.

The local superintendent is A. Rhodes.

GEOLOGY.

The whole region is characterized by swelling uplands of coarse and medium fine sand, having an aggregate thickness of perhaps 300 feet. Geologically it belongs to what is known as the "Potomac" formation. Though mainly sand, the soil has a great deal of clayey matter and loam mingled with it, the clay having been derived from the washing down of a formation subsequent to the Potomac. Whatever of fertility the land possesses is due to this clayey matter. In addition to these diffused particles there are found in the deep cuts of the railways irregular layers of clay, and occasional thin layers of lignitic material, the most notable of which outcrops at the surface two or three miles southeast of Southern Pines.

From these great sandy uplands vast stores of water drain to the streams running towards the Atlantic Coast, and plentiful supplies of very pure water are had by sinking wells from 60 to 300 feet deep.

CLIMATIC CONDITIONS.

Regular meteorological observations were not commenced at the farms until late in 1896, and therefore can not be of use in this report. As noted in the First Annual Report, there is but little positively known of the meteorology of the region immediately surrounding Southern Pines; but consecutive records have been kept for many years at ten stations immediately surrounding Moore County. This county occupies the southern portion of the central district of North Carolina, and has a higher temperature and a greater rainfall than the mean of the district. The county is on the same parallel as Southern Algeria, which is about thirteen degrees south of the finest wine-growing sections of the old world.

The following record of normal climatic conditions is on the authority of the North Carolina Climate and Crop Service, and includes the average of ten years' consecutive observations:

Normal Temperature and Possible Extremes for Moore County.

Month.	Normal.	Possible Maximum.	Possible Minimum.
January	42	80	8
February	46	80	5
March	50	91	21
April	61	97	28
May	69	98	38
June	76	103	48
July	79	103	50
August	76	100	52
September	70	103	44
October	59	90	30
November	51	80	16
December	45	75	7

The mean annual temperature for the county is over 60 degrees Fahrenheit, with spring and autumn means also 60, summer 77, and winter 44 degrees. The warmest month at Southern Pines is July, when the mean is 80 degrees; and the coldest month is January, with a normal mean of 42. The temperature conditions were discussed somewhat in detail in the Report for 1895.

The following table shows the average precipitation in the Southern Pines section, and also the number of days marked by a rainfall:

Normal Precipitation and Number of Rainy Days for The Southern Pines Section.

Month.	Normal Precipitation.	Rainy Days.
January	4.70	12
February	4.03	10
March	4.34	11
April	3.14	9
May	4.72	10
June	4.30	10
July	6.44	12
August	6.41	12
September	3.46	8
October	3.36	7
November	2.83	7
December	3.03	8

The rains in this section generally occur with local storms, which are most frequent in July and August, giving these months the largest number of rainy days. Amounts of rainfall exceeding ten inches per month have occurred in May, July and August, at Southern Pines, namely: 10.83, July, 1892; 11.08, May, 1891; 10.58, August, 1891, but there is no record of less than 1.00 inch per month. The amount of snowfall in winter is small, and what does fall rarely remains on the ground more than an average of two days.

On the whole, with respect to precipitation, this section may be considered well adapted to the purpose of horticulture, though the amount furnished seems to be in excess of the requirements of crops if compared, for example, with the amount received in the vineyard section of France.

The prevailing winds over Moore County are more nearly south than southwest during the season of growth, with a velocity rarely having an injurious force. The average annual cloudiness is somewhat less than fifty per cent. but higher in January and August than during the remaining months of the year. The normal number of clear days is 125; partly cloudy 130; and cloudy 110. There is plenty of sunshine.

THE SOIL AND ITS COMPARATIVE COMPOSITION.

The soil is sandy, containing but little clay, humus, or vegetable matter, other than the roots of the pines and scrub oaks which recently covered the soil. The herbaceous growth is chiefly wire-grass (*Aristida stricta, Mx.*), blue lupin (*Lupinus diffusus, Nutt*). false indigo *(Baptisia Villosa, Ell.)*, and different leguminous and orchidaceous plants of less importance.

The examination of the soil to determine its composition included both chemical and physical analyses. The samples were taken by

driving into the soil a two-inch wrought iron pipe bevelled to a sharp edge. The first six inches thus taken were designated as the *Top-soil,* and the twelve inches immediately underneath, that is from six to eighteen inches below the surface, was called the *Sub-soil.* The samples taken in this way were partially dried in the sun, then transferred to the laboratory and completely air-dried in the shade.

A series of samples was taken in the north and south roadway, in the fruit tract, after the field had been laid out and planted. Six portions (top-soil and sub-soil) were sampled at distances about 300 feet apart and carefully mixed. In the analyses given herewith, No. 94 represents the composite sample of the topsoil taken as above described, while No. 95 represents the sub-soil of the same composite samples. The chemical analyses were made by the official methods of the Association of Official Agricultural Chemists. In the top-soil the proportion of coarse particles and fine earth was 14.63 and 85.37 respectively, while in the sub-soil the coarse particles had decreased to 11.80 per cent., the fine earth being 89.20 per cent. In the analyses the fine earth only was treated with hydrochloric acid. The results were as follows:

Chemical Analysis of the Top-soil and the Sub-soil of the Fruit Farm.

	Top-soil (No. 94.)	Sub-soil (No. 95.)
	Per cent.	*Per cent.*
Moisture	.420	.205
Insoluble matter	96.010	97.290
Phosphoric acid	.037	.026
Volatile and organic matter	2.025	1.123
Lime	.040	.033
Sulphuric acid	.036	.041
Soluble Silica	.089	.062
Magnesia	.010	.015
Oxide of iron and alumina	.818	1.058
Potash	.027	.035
Soda	.113	.107
	99.625	99.995
Coarse particles	14.630	11.800
Fine earth	85.370	89.200
Nitrogen	.140	.014

The following physical analyses were made by Prof. Milton Whitney, Chief of the Division of Agricultural Soils, U. S. Department of Agriculture. He describes the Experimental Farm soils as being identical with the texture of the famous early truck lands of the Atlantic seaboard. The description of the samples is as follows: Nos. 104 to 108 are composite samples from four localities ten feet apart, taken from the virgin soil still uncleared. Different depths are represented, from the surface to six inches deep, and to a depth

of fifty-four inches. No. 95 is the sub-soil (six to eighteen inches) from the cleared area in the roadway, as represented in the chemical analysis above. No. 99 is a sub-soil from an uncleared virgin soil adjoining the locality from which No. 95 was taken.

Mechanical Analyses of Soil from the Fruit Farm, from the Surface to a Depth of Fifty-four Inches.

	Sample Numbers.						
	104	105	106	107	108	95	99
Depth in inches	0–6	6–18	18–30	30–42	42–54	6–18	6–18
Moisture	0.11	0.08	0.18	0.21	0.09	0.14	0.07
Organic matter	0.76	0.54	0.85	0.95	0.62	0.83	0.61
Gravel, 2 to 1 m.m	9.28	11.92	10.58	3.88	5.14	7.78	2.73
Coarse sand, 1 to .5 m.m	40.82	41.51	43.39	24.30	24.15	33.31	22.00
Medium sand, .5 to .25 m.m	31.57	27.20	25.94	32.89	31.82	35.26	42.40
Fine sand, .25 to .1 m.m	11.04	10.69	6.99	23.35	27.06	12.89	20.47
Very fine sand, .1 to .05 m.m	1.32	1.68	2.12	4.42	5.54	3.69	4.79
Silt, .05 to .01 m.m	2.03	0.37	2.89	2.67	1.26	2.93	3.03
Fine silt, .01 to .005 m. m	0.79	0.98	0.92	1.09	0.61	1.01	1.06
Clay, .005 to .0001 m. m	2.40	3.00	6.07	5.29	1.73	2.07	2.62

Within reasonable limits, the most important factors agriculturally indicated by a physical analysis are the last four classes in the table, viz.: very fine sand, silt, fine silt and clay. The differences indicated by the table imply, as a rule, a comparatively close agreement in the samples. This is shown by grouping the totals of the first four and the second four factors, as follows:

Sample.	Coarse Particles.	Fine Particles.
104	92.71	6.54
105	91.32	6.03
106	86.89	12.03
107	84.42	13.47
108	88.17	9.14
95	89.24	9.70
99	87.60	11.50

Before closing this chapter, it will be interesting to note the quantity of fertilizing ingredients in one acre of the top-soil. The weight of one acre of light, sandy soil, to the depth of six inches, is approximately 1,300 tons. The chemical analysis of the top-soil shows .027 per cent. potash, .037 per cent. phosphoric acid, and .14 per cent. nitrogen. The top-soil of one acre of this land contains, therefore:

Potash	2,052 lbs.
Phosphoric Acid	2,812 lbs.
Nitrogen	10,640 lbs.

Yet a very small application of fertilizer makes a wonderful gain in the crop-making power of the soil, as will be shown more fully in the discussion of results on the vegetable farm.

II.

THE PLAN OF THE EXPERIMENTAL TESTS.

The general plan of the experimental tests consists of a detailed study of the action of various fertilizing materials, under average conditions. More or less attention has also been paid to the adaptability of various kinds of fruits and vegetables, and the protection of trees, plants, etc., against the attacks of fungous diseases and injurious insects. The work is in two sections: the fruit farm and the vegetable farm.

The Fruit Department.

The scheme of investigations for the fruit department consists of a series of 29 plots, of one-tenth of an acre each, for each variety of tree fruit under investigation. The small fruit plots are one-fortieth of an acre each. The plan of the series of plots is shown by the accompanying plan of the fruit department (Fig. 2). The dimensions of each one-tenth acre plot are 49 ft. x 89.9 ft. There are seven series, as follows: I., small fruits; II., grapes; III., peaches; IV., plums; V., pears; VI., apples; VII., chestnuts. Each series of plots extends completely across the farm, so that any important inequality of the soil may be detected by comparing similarly numbered plots of the various series.

The operations in preparing the soil for cultivation were fully described in the Report of 1895. For the year 1896, the field was plowed April 1st, with a one-horse plow. Every ten or twelve days the whole department was thoroughly cultivated, with Planet, Jr., and Greensboro cultivators. This tillage was level and shallow, so as not to interfere with the roots of the plants and young trees.

The kinds of fruits selected were such as promised to yield the greatest profit on this kind of soil. The series in detail are as follows:

Series.	Planted.	Fruits.	Variety.
I	1896	*a* Strawberries	Lady Thompson.
	1896	*b* Raspberries	Cuthbert.
	1896	*c* Blackberries	Early Wilson.
II	1895	Grapes	Niagara and Delaware.
III	1896	Peaches	Elberta.
IV	1895	Plums	Abundance, Burbank, Maru, Ogon, Pool's Pride and Wayland.
V	1896	Pears	Kieffer.
VI	1896	Apples	McCuller's Winter.
VII	1896	Chestnuts	Japanese Mammoth.

Two varieties of grapes were planted on each of the one-tenth acre plots, in order to test the two leading types of the better class of shipping grapes. This allowed one-twentieth of an acre for each variety, and for each fertilizing application. The six varieties of plums were selected for cross-fertilization, there being two trees of each variety upon each plot. After planting, all the trees are pruned to a uniform height of 18 to 20 inches, to insure low heads, experience having shown that on this soil and in this climate high-headed trees are much affected by "sun-scald." The aim of future pruning will be to keep a round, open-headed tree, with fruiting wood well distributed throughout, so that the load of fruit may be evenly balanced.

Blackberries are pinched at a height of about three inches, to induce a bushy growth, as well as to protect the stems from "sun-scald."

The grapes are trained on the three-wire trellis (Munson system), the wires being four feet from the ground. The renewal system of pruning will be followed.

The strawberries are grown by the hill system, as being more easily comparable, and the relative yield better determined.

In all cases, shallow, clean cultivation is given from March 1st to August 1st. Some of the plots of each series are sown with a leguminous crop, which latter will be turned under to supply humus and nitrogen for succeeding fruit crops. The crops will be carefully graded and, excepting a sufficient quantity retained for analysis, will be shipped to the most promising markets, where they will be sold on their merits.

Fertilizers for the Fruit Department.

The fertilizing applications include the three main elements of plant food, namely:—nitrogen, potash and phosphoric acid. Some of the plots received also an application of lime, and upon others a leguminous crop was turned under as a green manure. Nitrogen was applied in the form of nitrate of soda, potash chiefly in the form of muriate, and phosphoric acid in the form of acid-phosphate.

The design of these tests is to determine more particularly the relative quantity of plant food required for the proper development of the trees and plants. To some extent nitrate of soda, as the sole source of nitrogen, is objectionable, because of its ready solubility in the soil, but its other advantages more than compensate for this objection. Muriate of potash was selected because it is the common source of agricultural potash, but tests are also being made with other salts of potash. In 1895 a part of the potash application on each plot was in the form of kainit, but, for several reasons, this plan was subsequently altered, so that after 1895 all the potash applications are made with muriate of potash, except upon the plots specially

designed for testing the various potash salts. Acid phosphate was selected as the form of phosphoric acid because that material is the most common source of supply.

The lime application consisted of 200 pounds per plot, the equivalent of 2,000 pounds per acre. This slaked lime was made with building lime, slaked with water to a powder. The slaking increased 100 pounds of lime to 180 pounds; the lime was weighed for application in the slaked form.

Green manuring was practiced by planting cow-peas in rows July 6th, and cultivating, except in the case of grapes, for which the peas were planted in strips, four feet wide, between the rows of grapes, and were not cultivated. The peas were thus planted in rows and strips, as the experience of 1895 indicated that peas sown broadcast had injured some of the plants, especially the grapes. On October 1st, these plots were planted to crimson clover, winter vetches, and Canada field peas; but they were all killed by unusually inclement weather before they could have had any appreciable effect.

Fertilizing Nomenclature.

The fertilizing applications on each of the one-tenth acre plots were as follows:—in which K, P, N, L, and G represent the fertilizing ingredients named below. Two plots (Nos. 8 and 21) were not fertilized in any way, for purposes of comparison.

K represents 50 pounds of actual potash per acre, from muriate, except on plots 1, 2, 3, and 29, on which kainit, sulphate of potash-magnesia, carbonate of potash-magnesia, and sulphate of potash are used respectively.

P represents 50 pounds of phosphoric acid (P2O5) per acre, from acid phosphate.

N represents 20 pounds of actual nitrogen per acre, from nitrate of soda.

L represents 2,000 pounds of slacked lime per acre.

G represents green manuring with cow-peas.

O represents plots on which no fertilizer is used.

Fractional or multiple applications are represented by the same system used in chemical notation; thus, K2PN indicates that two portions of potash were used, but only one each of nitrogen and phosphoric acid; the application per acre would be, therefore, 100 pounds of potash, 20 pounds of nitrogen and 50 pounds of phosphoric acid.

The plots are numbered from 1 to 29 beginning at the southwestern end of the farm. The fertilizers applied to the plots, in approximate amounts in pounds per acre, were as follows:

FERTILIZER APPLICATIONS—*Pounds Per Acre.*

No.	Symbol.	Nitrate of Soda.	Acid Phosphate.	Potash.	Remarks.
1	K_2PN	125	400	800	As Kainit.
2	K_2PN	125	400	400 600	As Sulphate of Potash-Magnesia.
3	K_2PN	125	400	100	As Carbt. Potash-Magnesia.
4	KP	----------	400	100	As Muriate.
5	KN	125	----------		" "
6	PN	125	400	----------	
7	KPN	125	400	100	As Muriate.
8	O	----------	----------	----------	
9	$K\frac{1}{2}PN$	125	400	50	As Muriate.
10	K_2PN	125	400	200	" "
11	K_3PN	125	400	300	" "
12	$KP\frac{1}{2}N$	125	200	100	" "
13	KP_2N	125	800	100	" "
14	KP_3N	125	1200	100	" "
15	$KPN\frac{1}{2}$	63	400	100	" "
16	KPN_2	250	400	100	" "
17	KPN_3	375	400	100	" "
18	$(K_2P)G$	----------	400	200	" "
19	$2(K_2P)G$	----------	800	400	" "
20	$2(K_2P)NG$	125	800	400	" "
21	O	----------	----------	----------	
22	K_2PNL	125	400	200	As Muriate.
23	K_2PGL	----------	400	200	" "
24	$\frac{1}{2}(K_2PN)GL$	63	200	100	" "
25	$(K_2PN)GL$	125	400	200	" "
26	$2(K_2PN)GL$	250	800	400	" "
27	$3(K_2PN)GL$	375	1200	600	" "
28	$4(K_2PN)GL$	500	1600	800	" "
29	K_2PN	125	400	200	As Sulphate.

The general plan of fertilizer applications is as follows:

UNFERTILIZED PLOTS.—Plots 8 and 21 received no fertilizer, and are designed to show the crop-making power of the soil without aid of any kind of plant food and also to show the exhaustion of successive cropping.

INCOMPLETE FERTILIZATION.—Plots 4, 5 and 6, received, respectively, KP, KN and PN. This group was designed to indicate the relative availibility of the natural supplies of plant food existing in the soil, and to determine if the fruit-grower could depend on such supplies in rational fertilization.

FERTILIZING POWER OF DIFFERENT FORMS OF POTASH.—Plots 1, 2, 3, 10 and 29 were fertilized with potash as kainit, sulphate of potash-magnesia, carbonate of potash-magnesia, muriate of potash, and sulphate of potash, respectively.

COMPARATIVE FERTILIZING POWER OF POTASH.—Plots, 7, 9, 10 and 11 each received a complete fertilizer; plot 7, with the normal

ration of potash; plot 9, with one-half the normal ration; plot 10, double the normal ration; and plot 11, with three times the normal ration.

COMPARATIVE FERTILIZING POWER OF NITROGEN.—Plots 7, 15, 16, and 17 were fertilized with complete fertilizers; plot 7 with the normal ration of nitrogen; plot 15, with one-half the normal ration; plot 16, double the normal ration; and plot 17, three times the normal ration of nitrogen.

COMPARATIVE FERTILIZING POWER OF PHOSPHORIC ACID.—Plots 7, 12, 13, and 14, received complete fertilization; plot 7, with the normal ration of phosphoric acid; plot 12, with one-half the normal ration; plot 13, with double the normal ration; and plot 14, with three times the normal ration of phosphoric acid.

COMPARATIVE EFFECT OF LIME.—Plots 10, 22, and 29, received complete fertilization; plot 10 received the normal ration of both nitrogen and phosphoric acid, and double the normal ration of potash. For fruits and vegetables, this is established as the standard ration. Plot 22 received the same, with the addition of lime. Plot 29 is a "check plot," receiving the same fertilizer as plot 10, but having its potash in a different form. Plots 1, 2, and 3, might also serve as check plots, but for the fact that in 1895 they received incomplete fertilization.

COMPARATIVE EFFECT OF GREEN MANURING.—Plots 10, 29, 18, 19, and 20, are included in this group. Plots 10 and 29 are check plots, as in the case of lime. Plots 18 and 19 received no fertilizer nitrogen, but an ample supply should have been obtained from the green manure. Plot 18 received twice the normal ration of potash, and the normal ration of phosphoric acid. Plot 19 received four times the normal ration of potash, and a double ration of phosphoric acid. Plot 20 received the same potash and phosphoric acid as plot 19, and also a normal ration of nitrogen.

COMPARATIVE EFFECT OF LIME AND GREEN MANURE COMBINED. —In this group are plots 23, 24, 25, 26, 27, and 28. All these plots received both lime and green manure; and, in addition, plot 23 received double the normal potash ration and the normal phosphoric acid ration; plot 24 received the normal potash ration and one-half each of the normal rations of nitrogen and phosphoric acid; plot 25 received double the fertilizer ingredients of plot 24; plot 26 received double the fertilizer application to plot 25; plot 27 received three times the fertilizer application of plot 25; plot 28 received four times the fertilizer application of plot 25.

Fertilizer Preparation and Distribution.

The fertilizing materials were carefully mixed, and samples taken for analysis. For the materials used in 1896 the analyses were:

Kainit	contained	12.20	per cent	actual	potash.
Muriate of Potash	"	50.16	"	"	"
Sulphate of Potash	"	47.70	"	"	"
Sulphate of Potash-Magnesia	"	26.56	"	"	"
Carbonate of Potash-Magnesia		19.78	"	"	"
Nitrate of Soda	contained	15.94	"	nitrogen.	
Acid Phosphate	"	14.76	"	available phos. acid.	

The amounts of different materials required to furnish the normal rations of potash, nitrogen, and phosphoric acid were calculated for each plant in the case of grapes, peaches, pears, plums, and chestnuts, and for each row of plants in the case of grapes, blackberries, strawberries, and raspberries. These amounts were carefully weighed and carried to the field in paper bags, and distributed evenly by hand over the area around the trees and plants indicated further on in this Report. By this procedure each plant and tree received its full application of the fertilizing ingredients. This portion of the work was done by experienced men from the chemical division of the North Carolina Experiment Station.

It was not intended that the young plants and trees should receive the full ration during the earlier periods of growth, but that the amount should be increased from year to year until the development of the plant should warrant the full ration. In the case of lime and green manuring, however, the full normal amounts were given from the beginning. The following table shows the proportions of the normal ration applied in 1896:

1. Strawberries	one-half	normal	application.
2. Blackberries	"	"	"
3. Raspberries	"	"	"
4. Grapes	three-fourths	"	"
5. Peaches	one-fifth	"	"
6. Plums	one-fourth	"	"
7. Pears	one-fifth	"	"
8. Apples	one-fifth	"	"
9. Chestnuts	one-fortieth	"	"

These parts of normal applications, when expressed in grams of the different fertilizer materials, and applied according to the plan of experiments, would be:

For Plums:

Acid Phosphate	320	grams	per tree.
Nitrate of Soda	121	"	"
Muriate of Potash	94	"	"
Kainit	775	"	"
Sulphate of Potash-Magnesia	356	"	"
Sulphate of Potash	99	"	"
Carbonate of Potash-Magnesia	478	"	"

For Peaches:

Acid Phosphate	171	grams per tree.
Nitrate of Soda	64	" "
Muriate of Potash	50	" "
Sulphate of Potash	53	" "
Kainit	413	" "
Sulphate of Potash-Magnesia	190	" "
Carbonate of Potash-Magnesia	255	" "

For Pears:

Acid Phosphate	205	grams per tree.
Nitrate of Soda	77	" "
Muriate of Potash	60	" "
Sulphate of Potash	64	" "
Kainit	496	" "
Sulphate of Potash-Magnesia	228	" "
Carbonate of Potash-Magnesia	30[illegible]	" "

For Apples:

Acid Phosphate	384	grams per tree.
Nitrate of Soda	145	" "
Muriate of Potash	113	" "
Sulphate of Potash	119	" "
Kainit	930	" "
Sulphate of Potash-Magnesia	427	" "
Carbonate of Potash-Magnesia	573	" "

For Chestnuts:

Acid Phosphate	12.0	grams per tree.
Nitrate of Soda	2.5	" "
Muriate of Potash	3.5	" "
Sulphate of Potash	3.7	" "
Kainit	29.0	" "
Sulphate of Potash Magnesia	13.3	" "
Carbonate of Potash-Magnesia	17.9	" "

For Grapes:

Acid Phosphate	2,305	grams per row of 13 vines.
Nitrate of Soda	810	" " "
Muriate of Potash	678	" " "
Sulphate of Potash	713	" " "
Kainit	5,577	" " "
Sulphate of Potash-Magnesia	2,562	" " "
Carbonate of Potash-Magnesia	3,440	" " "

For Strawberries:

Acid Phosphate	120	grams per row, 16 rows per plot.
Nitrate of Soda	45	" " " "
Muriate of Potash	35	" " " "
Sulphate of Potash	37	" " " "
Kainit	290	" " " "
Sulphate of Potash-Magnesia	133	" " " "
Carbonate of Potash Magnesia	179	" " " "

FOR RASPBERRIES AND BLACKBERRIES;

Acid Phosphate	240	grams per	row,	8 rows	per plot.
Nitrate of Soda	91	"	"	"	"
Muriate of Potash	71	"	"	"	"
Sulphate of Potash	75	"	"	"	"
Kainit	581	"	"	"	"
Sulphate of Potash-Magnesia	267	"	"	"	"
Carbonate of Potash-Magnesia	358	"	"	"	"

The fertilizers as above stated were applied to the plots about the middle of April, except half the quantity of nitrate of soda, which was applied in two applications; one at the same time as the potash and phosphoric acid, and the other about the middle of June. The application of lime was made late in April, except on those plots receiving green manure, in which case the lime was applied immediately after the green manure was plowed under.

Method of Recording Growth, Making Notes, and Securing Photographic Records.

It was decided to make a complete record of the progress of the growth of the various series, and note the effect of the different applications and their treatment upon the several plots. The condition of the plots was noted carefully three times during the season, namely: June 1st to 3rd; August 7th to 10th; October 7th to 9th. In the record, each plant in the plum and peach plots is treated individually; but for vines on the grape plots only every second plant in each alternate row was noted, except where intermediate plants were dead or missing, when the fact was also recorded. The records of the first examination embody the following facts: 1. Plant number in plot; 2. Height pruned at planting; 3. Length of new growth; 4. Insect damages; 5. Fungous damages; 6. General remarks. The second examination records as follows: 1. Plant number; 2. Average growth of new shoots, in inches; 3. Number of shoots; 4. General vigor of plants; 5. Insect damages; 6. Fungous damages; 7. General remarks. At the third examination the following points are recorded for each plant: 1. Plant number; 2. General appearance; 3. Condition of winter buds; 4. Condition of bark; 5. Color and condition of foliage; 6. Average length of new shoots; 7. Number of new shoots per tree; 8. General remarks.

In connection with an account of the growth of the trees, vines, and plants by means of personal observations, it was determined to have further records by means of photographs. The fungous and insect enemies and their treatment were rather fully described in the Report for 1895, to which the experience of 1896 can add little or nothing decisive. The Experimental Farm is, as yet, too young in years to accumulate extensive data on these points.

III.

THE VEGETABLE DEPARTMENT.

The land for the vegetable department of the farm was cleared in the spring of 1895, in the same manner as the tract for the fruit department. (See the Report for 1895). It was not ready for cultivation in 1895, but was plowed and sown broadcast in Unknown or Wonderful peas, and at the rate of one and one-fourth bushels per acre, and received no fertilizer application. The growth of the vines was fair, the peas were turned under in the spring of 1896, and the land harrowed and put in good order for garden crops.

The scheme of investigations of the vegetable department consists of a series of 20 plots, of one-twentieth of an acre each. The dimensions of each one-twentieth acre plot were 25.6ftx85ft. Each series of plots has a twenty-foot driveway on either side; the individual plots are separated by a ten-foot pathway. The series of 1896 were as follows: 1. Sweet corn; 2. Sweet potatoes; 3. Cabbage; 4. Asparagus; 5. Tomatoes; 6. Snap beans; 7. Cucumbers; 8. Irish potatoes. Each series of plots extends completely across the farm, so that any notable irregularity in the soil may be detected by comparing similarly numbered plots of the various series.

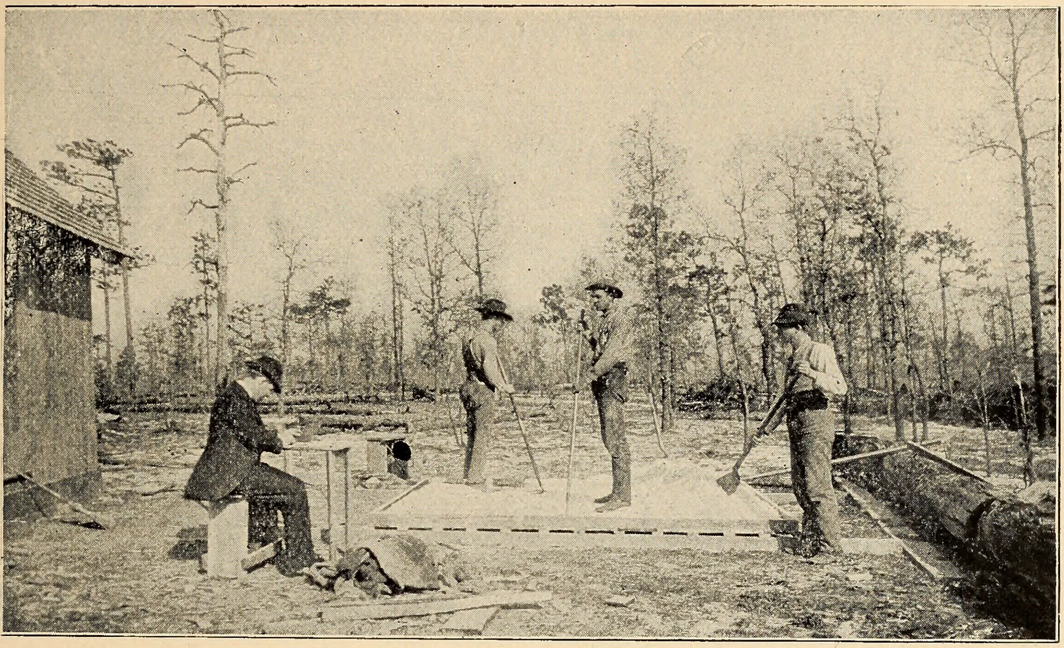
The ground was kept in the best possible condition. The cultivation was with hand and horse cultivators, the land being gone over every eight or ten days. The vegetables selected for 1896 were as follows:

	Varieties.
1. Sweet Corn	Station Hybrid.
2. Sweet Potatoes	White Southern Queen.
3. Cabbage	Early Wakefield.
4. Asparagus	Palmetto.
5. Tomatoes	Livingstone's Beauty.
6. Snap Beans	Valentine's.
7. Cucumbers	White Spine.
8. Irish Potatoes	White Bliss.

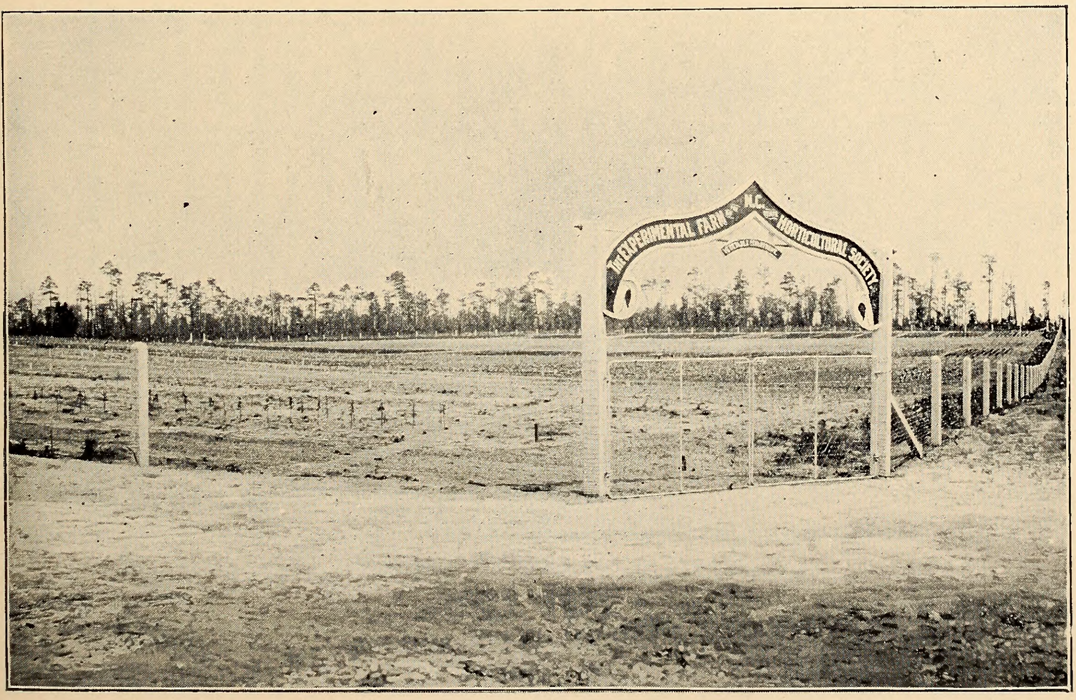
Details of Fertilizing for the Vegetable Department.

The phosphoric acid and potash were applied at the time of planting; the nitrogen in fractional applications. The details are given under the special series considerations, further on in this Report. The fertilizer nomenclature is precisely the same as in the fruit department, except that the symbols represent larger quantities, as follows:

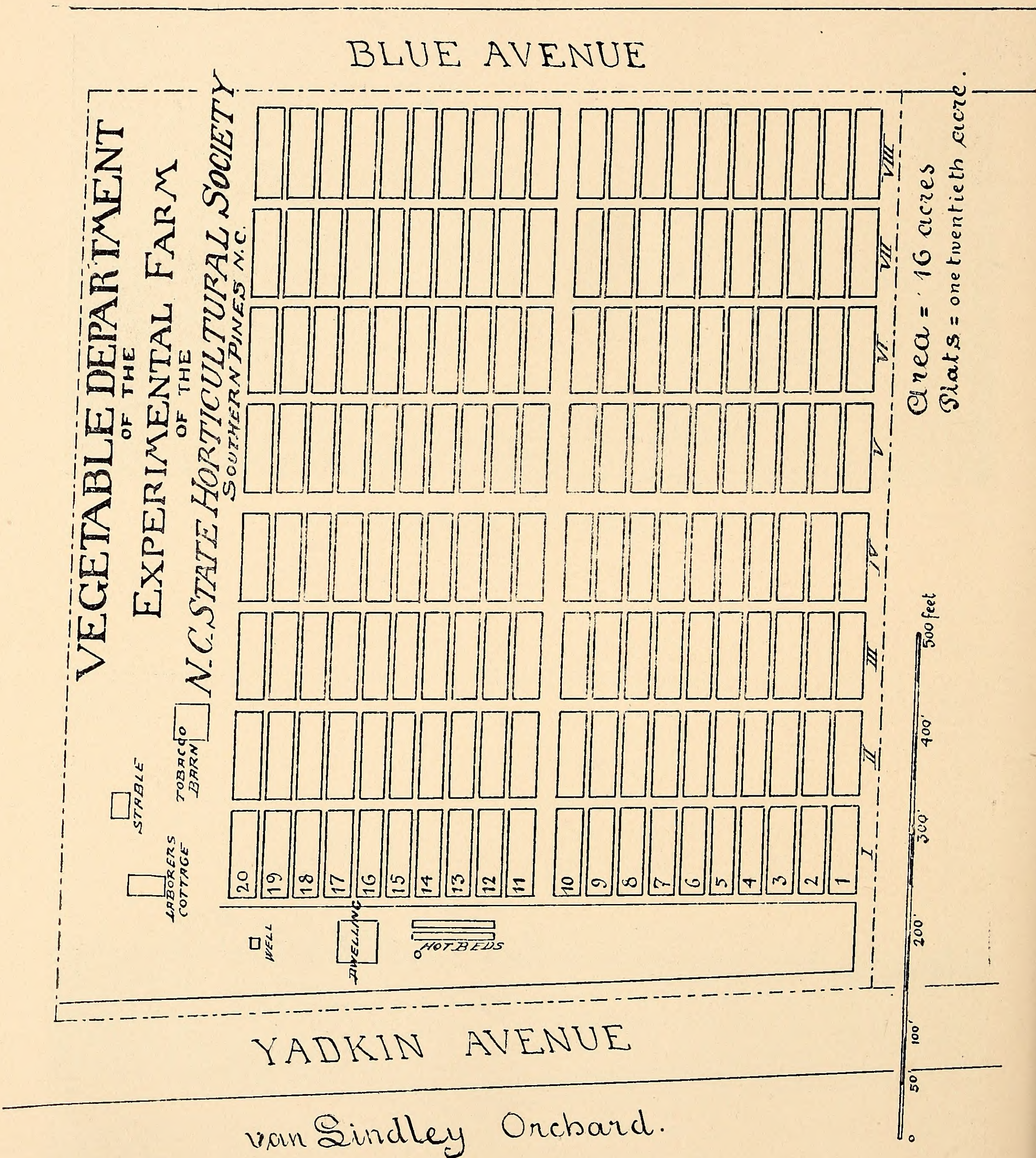
K represents 80 pounds per acre of actual potash (K2O), or 4 pounds per plot. The potash is from muriate of potash, except plots 9, 10, 11, and 12, on which sulphate of potash, kainit, sulphate of



Preparation of Fertilizers.



Entrance to Vegetable Department.



Showing Vegetable Department Experimental Farm, Southern Pines, N. C.

potash-magnesia, and carbonate of potash-magnesia are used respectively.

P represents 50 pounds of available phosphoric acid per acre, from acid phosphate.

N represents 40 pounds of nitrogen per acre, from nitrate of soda.

L represents 2,000 pounds of slaked lime per acre.

G represents green manuring.

O represents plots on which no applications are made.

Fractional or multiple applications are represented by the same system used in the fruit department. The plots are numbered from 1 to 20, beginning at the western side of the farm. The fertilizers applied to the plots, in approximate amounts in pounds per acre, were as follows:

FERTILIZER APPLICATIONS—*Pounds Per Acre.*

No.	Symbol.	Nitrate of Soda.	Acid Phosphate.	Potash.	Remarks.
1	PNGL	250	400		
2	KNGL	250	....	160	As Muriate.
3	KPGL	....	400	160	" "
4	KPNL	250	400	160	" "
5	KPNG	250	400	160	" "
6	KPN	250	400	160	" "
7	O	....	....	....	
8	KPNGL	250	400	160	As Muriate.
9	KPNGL	250	400	160	As Sulphate.
10	KPNGL	250	400	160	As Kainit.
11	KPNGL	250	400	160	As Sulph. of Pot.-Magnesia.
12	KPNGL	250	400	160	As Carbt. of Pot.-Magnesia.
13	O	....	....	....	
14	$K\frac{1}{2}$PNGL	250	400	80	As Muriate.
15	$K\frac{3}{4}$PNGL	250	400	120	" "
16	K_2PNGL	250	400	320	" "
17	KP_2NGL	250	800	160	" "
18	KPN_2GL	500	400	160	" "
19	2(KPN)GL	500	800	320	" "
20	3(KPN)GL	750	1200	480	" "

The general plan of fertilizer application is as follows:

UNFERTILIZED PLOTS.—Plots 7 and 13 received no fertilizer, lime, or green manure, and are designed to show the crop-making power of the soil in a natural condition, aided only by tillage.

INCOMPLETE FERTILIZATION.—Plots 1, 2, and 3, received of chemical fertilizer PN, KN, and KP, respectively. All of them received lime. Green manure could not have made any showing in 1896, as this was the first year of its use. This group should measure the availability of the plant food existing in the soil naturally.

FERTILIZING POWER OF DIFFERENT FORMS OF POTASH.—Plots 8,

9, 10, 11, and 12, were fertilized with potash as muriate, sulphate, kainit, sulphate of potash-magnesia, and carbonate of potash-magnesia, respectively. In other respects they were all treated precisely the same.

COMPARATIVE FERTILIZING POWER OF POTASH.—Plots 8, 14, 15, and 16, each were fertilized precisely the same, except the ration of potash was normal, one-half normal, three-quarters normal, and twice the normal, respectively.

COMPARATIVE FERTILIZING POWER OF NITROGEN.—Plots 8 and 18 were fertilized precisely the same, except that the latter plot received a double ration of nitrogen.

COMPARATIVE FERTILIZING POWER OF PHOSPHORIC ACID.—Plots 8 and 17 were fertilized precisely the same, except that the latter received a double ration of phosphoric acid.

EFFECT OF INCREASING THE APPLICATION.—Plots 8, 19, and 20, were fertilized with normal, double, and triple rations; in each case accompanied by lime and green manuring.

COMPARATIVE EFFECT OF LIME.—Plots 4 and 6 were fertilized the same, except that the former received an application of lime.

COMPARATIVE EFFECT OF GREEN MANURING.—Plots 5 and 6 were fertilized the same, except the former received the green manuring treatment.

COMPARATIVE EFFECT OF LIME AND GREEN MANURING COMBINED.—Plots 6 and 8 were fertilized the same, except the latter received both lime and the green manuring treatment.

The same attention to minute details was observed on the vegetable plots as on the fruit plots. The fertilizer materials used were of the same lot as those used on the fruit farm. The method of recording growth, etc., while not so elaborate as in the case of the fruit farm, was sufficiently thorough to make clear the effects on the various plots of the method of fertilization used. All products were carefully harvested and weighed, and records accurately kept.

IV.

GENERAL RESULTS OF THE FRUIT FARM FOR 1896.

The Supervising Committee wish it to be clearly understood that these interesting experiments have not gone far enough to allow positive conclusions to be stated. The soil is yet new and not in the best mechanical or physical condition, and, while this fact is equally true of all the plots, the total development is so small that accidental favorable conditions of a very moderate character will tend to produce very disproportionate *relative* results. Therefore it is necessary at stages of the experiments to omit all exceptionally disproportionate results for purposes of comparison.

The following study of averages is confined to the results with grapes, both varieties, apples, plums, and peaches.

Methods of Comparison.

Two factors of real value are used for comparing the results on the different plots; one having the *Weight of Prunings,* computed to a full stand, as its basis; the other, the observed *Vigor* of the trees and vines on the different plots. The results are computed on a basis of a value of 100 for the unfertilized plots. As will be noted further on, the two O plots showed considerable differences in values, indicating a better condition of soil in the higher-numbered plots. (This point is also apparent for *Vigor* values). In computing ratios, the results on plot 8 were used as the divisor for plots 1 to 14, inclusive; the results on plot 21 were used as the divisor of plots 15 to 29, inclusive. The *Vigor* ratios are computed on the same basis.

Comparison of Results on the Unfertilized Plots.

These results indicate that the natural crop-making power of the soil increases slightly from plot 1 towards the centre of the series, and again showing a decrease as plot 29 is approached. The following table gives the figures in detail:

Series.	Weight of Prunings.	
	Plot 8.	Plot 21.
Grapes, Delaware	100	166
Niagara	100	133
Peaches	100	204
Plums	100	102
Apples	100	84
Average	100	138
	Vigor.	
Grapes, Delaware	100	140
Niagara	100	140
Peaches	100	125
Plums	100	107
Apples	100	100
Average	100	122

With this explanation of the methods of comparison used, we give herewith a table showing the comparative results of the fruit tests for 1896:

Table Showing the Ratios of Production, based on the Air-Dry Weight of Prunings.

Plot.	Symbol.	Grapes Delaware.	Grapes Niagara.	Peaches	Plums.	Apples.	Average.
1	K_2PN	77	103	*154*	108	133	105
2	K_2PN	*257*	125	*172*	99	117	114
3	K_2PN	*141*	*183*	97	96	133	108
4	KP	*164*	110	99	112	113	109
5	KN	*165*	130	*230*	*186*	135	133
6	PN	*201*	143	*171*	*226*	126	135
7	KPN	205	153	182	2[illegible]0	127	177
8	O	100	100	100	100	100	100
9	$K\frac{1}{2}PN$	198	138	130	129	147	158
10	K_2PN	184	152	*114*	148	138	156
11	K_3PN	193	200	136	*88*	152	170
12	$KP\frac{1}{2}N$	144	150	134	140	*107*	142
13	KP_2N	242	243	202	*107*	119	201
14	KP_3N	242	227	212	*109*	123	201
15	$KPN\frac{1}{2}$	110	112	*65*	131	*105*	138
16	KPN_2	152	172	125	*70*	*116*	150
17	KPN_3	153	192	160	152	145	160
18	K_2PG	*193*	161	105	*91*	139	135
19	$2(K_2P)G$	*215*	*180*	121	*97*	147	134
20	$2(K_2P)NG$	156	*219*	176	125	136	148
21	O	100	100	100	100	100	100
22	K_2PNL	194	161	*76*	*292*	111	155
23	K_2PGL	*214*	158	98	*92*	120	125
24	$\frac{1}{2}(K_2PN)GL$	166	*191*	*96*	*152*	136	151
25	$(K_2PN)GL$	171	166	123	*107*	173	158
26	$2(K_2PN)GL$	165	165	125	133	163	150
27	$3(K_2PN)GL$	171	190	150	*113*	*124*	170
28	$4(K_2PN)GL$	186	210	165	158	*220*	180
29	K_2PN(*Sul*)	*219*	200	134	*221*	153	162

The ratios in italic were omitted in making up the averages, as unduly affecting the results from purely accidental reasons. In the detailed study of individual series, to be made later on, the averages will be substituted for ratios italicized in this table.

Table Showing the ratios of Fertilizing Effect, based on the Observed Vigor of the Trees and Vines.

Plot.	Symbol.	Grapes, Delaware.	Grapes, Niagara.	Peaches.	Plums.	Apples.	Average.
1	K_2PN	100	100	175	125	129	118
2	K_2PN	100	100	200	122	129	130
3	K_2PN	100	100	150	118	129	119
4	KP	140	140	175	125	414	139
5	KN	140	140	175	143	114	142
6	PN	160	160	200	165	129	163
7	KPN	140	140	225	145	114	153
8	O	100	100	100	100	100	100
9	$K_{\frac{1}{2}}PN$	140	140	175	136	129	144
10	K_2PN	160	160	150	118	114	140
11	K_3PN	160	160	200	113	114	139
12	$KP_{\frac{1}{2}}N$	140	140	200	139	114	147
13	KP_2N	180	180	250	130	100	168
14	KP_3N	180	180	225	136	143	173
15	$KPN_{\frac{1}{2}}$	100	100	140	130	129	120
16	KPN_2	129	129	190	139	114	140
17	KPN_3	129	129	180	127	129	139
18	$(K_2P)G$	100	100	140	109	100	110
19	$2(K_2P)G$	114	114	140	101	100	114
20	$2(K_2P)NG$	129	129	200	135	114	141
21	O	100	100	100	100	100	100
22	K_2PNL	143	142	200	150	114	150
23	K_2PGL	114	114	160	120	114	124
24	$\frac{1}{2}(K_2PN)GL$	114	114	160	125	114	125
25	$1(K_2PN)GL$	100	100	180	125	100	121
26	$2(K_2PN)GL$	114	114	180	122	114	129
27	$3(K_2PN)GL$	114	114	190	122	114	128
28	$4(K_2PN)GL$	100	100	200	117	100	123
29	K_2PN(*Sul*)	143	143	180	142	129	165

The Influence of Fertilizers as Shown by the Results.

In the present study of the effects of fertilizing, only the production ratios based on the weights of air-dried prunings is considered. A comparison with the observed vigor follows. The unfertilized plots are both valued at 100, and every increase over that sum indicated a direct percentage of gain effected by the fertilizers used.

Incomplete Fertilization.—The plots of this group are Nos. 4, 5, and 6, representing a gain over unfertilized plots of 9, 33 and 35 per cent. respectively. KP gives a gain of only 9 per cent., KN shows a gain of 33 per cent., and PN a gain of 35 per cent.

Fertilizing Power of Different Forms of Potash.—The plots of this group are Nos. 1, 2, 3, 10, and 29, representing a gain over unfertilized plots of 5, 14, 8, 56 and 62 per cent. respectively. As plots 1, 2 and 3 were not treated with complete fertilizers in 1895 they can not be justly compared with plots 10 and 29. Compared separately, the fertilizing power of the first three plots seems to indicate the following ratio: Kainit 100, carbonate of potash-magnesia

103, and sulphate of potash-magnesia 109. Plots 10 and 29 indicate a value of sulphate of potash of 104, as compared with muriate of potash at 100.

COMPARATIVE FERTILIZING POWER OF POTASH.—The plots of this group are Nos. 7, 9, 10 and 11, representing a gain over unfertilized plots of 77, 58, 56 and 70 per cent. respectively. The statement is as follows:

Plot 8	O	100
" 7	KPN	177
" 9	$K\frac{1}{2}PN$	158
" 10	K_2PN	156
" 11	K_3PN	170

This seems to imply that the normal ration selected by the Supervising Committee is about correctly proportioned.

COMPARATIVE FERTILIZNG POWER OF NITROGEN.—The plots of this group are Nos. 7, 15, 16 and 17, representing a gain over unfertilized plots of 77, 38, 50 and 60 per cent. respectively. The statement is as follows:

Plot 8	O	100
" 7	KPN	177
" 15	$KPN\frac{1}{2}$	138
" 16	KPN_2	150
" 17	KPN_3	160

The results emphasize the remarks made in reference to the preceding group.

COMPARATIVE FERTILIZING POWER OF PHOSPHORIC ACID.—Plots 7, 12, 13 and 14 comprise this group, showing a gain over the unfertilized plots of 77, 42, 101 and 101 per cent. respectively. The statement is as follows:

Plot 8	O	100
" 7	KPN	177
" 12	$KP\frac{1}{2}N$	142
" 13	KP_2N	201
" 14	KP_3N	201

The results seem to indicate that a slight gain was effected by increasing the normal ration of phosphoric acid, as shown by the following comparative statement:

Normal ration	100
One-half normal ration	80
Normal ration doubled	114
Normal ration tripled	114

It is evident that three times the normal ration was not marked by noticeable results, and even the gain from doubling it is not very great.

COMPARATIVE EFFECT OF LIME.—Plots 10 and 22 are included in this group. The results are:

Plot 10	K_2PN	156
" 22	K_2PNL	155

The results are practically identical, though plot 22 will no doubt change its relative position in later years.

COMPARATIVE EFFECT OF GREEN MANURING.—This group is composed of plots 10, 18, 19 and 20. The results are:

Plot 10	K_2PN	156
" 18	$(K_2P)G$	135
" 19	$2K_2P)G$	134
" 20	$2(K_2P)NG$	148

Green manuring has not so far proved beneficial, undoubtedly due to the fact that the legumes drew heavily on the water supply of the soil. This result may be changed in later years. One object in using these plants is to prevent losses of available fertilizing material through drainage, *i. e.*, by maintaining a cover crop on the soil. It is quite possible that the green manure crop has seriously robbed the young and shallow-rooted trees and vines of the necessary moisture for a full development, by the evaporation incident to their own development. At this early stage in the experiments the returns from fertilizing material stored by the green manure could scarcely have made a showing, and may later on materially change these figures.

COMPARATIVE EFFECT OF LIME AND GREEN MANURE COMBINED.—In this group are plots 23, 24, 25, 26, 27 and 28. The statement of results is as follows:

Plot 23	K_2PGL	125
" 24	$\frac{1}{2}(K_2PN)GL$	151
" 25	$(K_2PN)GL$	158
" 26	$2(K_2PN)GL$	150
" 27	$3(K_2PN)GL$	170
" 28	$4(K_2PN)GL$	180

The record of plots can not well include the production of green manure crops as they are turned under as a fertilizer, but such data would possibly throw some additional light on the propensity of the green manure crops to rob the plants and vines of moisture. In all these plots experimenting with green manure, the potash ration is doubled as compared with the nitrogen and phosphoric acid, as it is a well-recognized fact that leguminosæ require relatively large quantities of potash.

Plot 23 shows plainly the lack of nitrogen as compared with plot 25, yet plot 24, with a one-half normal ration of nitrogen and phos-

phoric acid, falls but a trifle behind plot 25. Plot 26, with a double ration of KPN (as compared with plot 25), shows no increase, but plots 27 and 28, with a three times and four times the standard ration respectively, show gains. The latter, however, is the only plot in the series which shows a gain over the normal ration of plot 7, excepting plots 13 and 14.

So far as this evidence goes, little or no benefit is shown from the use of a green manure, as the injury due to increased evaporation, and consequent deficiency of moisture, obscures the effect. Lime is supposed to greatly aid in converting the fertilizing matter in green crops into available forms, but it fails to make a tangible showing in this instance. At the same time, it is necessary to refer to the fact that the length of time these experiments have been in operation is too short to enable the ration of lime and green manure to make their influence apparent.

Influence of Fertilization as Shown by Vigor of Trees and Vines.

The system of recording the vigor shown by trees and vines was based on a series of ten units, the factor 10 indicating the greatest excellence and the factor 1 indicating a very low condition of development. For direct comparison with the *Weights of Prunings,* these Vigor factors are expressed in ratios. The ratios are determined by using the results on plot 8 as a basis, and finding the percentage of increase over plot 8 for plots 1 to 14, inclusive; for plots 15 to 29 inclusive, the results on plot 21 are used as the basis. The observed vigor of the various groups of plots was as follows:

Fertilizing Power of Different Forms of Potash.—This group includes plots 1, 2, 3, 10, and 29, representing gains of 18, 30, 19, 40, and 65 per cent., respectively. Plots 1, 2, and 3 suffer from not having received a complete fertilizer in 1895. Plots 10 and 29 show a value of 100 for muriate of potash, as compared with a value of 117 for sulphate of potash. It is interesting to note that the results on plots 1, 2, and 3 compare closely with the same plots compared by weights of prunings. The figures are: Kainit 100, carbonate of potash-magnesia 101, sulphate of potash-magnesia 111.

Comparative Fertilizing Power of Potash.—The plots of this group are Nos. 7, 9, 10, and 11, representing gains of 53, 44, 40, and 39 per cent., respectively. The statement is as follows:

Plot 8	O	100
" 7	KPN	153
" 9	K½PN	144
" 10	K_2PN	140
" 11	K_3PN	139

The results practically confirm those of the *Weight of Prunings* series of comparisons.

Comparative Fertilizing Power of Nitrogen.—This group includes plots 7, 15, 16, and 17, representing a gain of 53, 20, 40 and 39 per cent., respectively. The statement in detail is:

Plot 8	O	100
" 7	KPN	153
" 15	$KPN\frac{1}{2}$	120
" 16	KPN_2	140
" 17	KPN_3	139

These results conform closely with those of the Weight of Prunings comparisons. It is notable, however, that an increase of nitrogen alone fails to be accompanied by gains over the normal ration.

Comparative Fertilizing Power of Phosphoric Acid.—Plots 7, 12, 13 and 14 comprise this group, making a gain of 53, 47, 68, and 73 per cent., respectively. These results compare closely with those of the previous comparative method, as shown by the following statement:

	Vigor.	Prunings.
Plot 7. Normal ration	100	100
" 12. One-half Normal ration	96	80
" 13. Normal ration doubled	110	114
" 14. Normal ration tripled	113	114

Phosphoric acid seems to make a slight gain by increasing the normal ration, though the loss by decreasing the normal ration one-half is very slight.

Comparative Effect of Lime.—Plots 10 and 22 comprise this group, representing gains of 40 and 50 per cent., respectively. Lime shows somewhat to a better advantage in the Vigor observations than it does in the Weight of Prunings' comparisons.

Comparative Effects of Green Manuring.—Plots 10, 18, 19 and 20 are included in this group, showing gains over unfertilized plots of 40, 10, 14 and 41 per cent. respectively. The details are:

Plot 10	K_2PN	140
" 18	$(K_2P)G$	110
" 19	$2(K_2P)G$	114
" 20	$2(K_2P)NG$	141

As before noted, green manuring seems a slender aid at this stage of development. Plot 20 alone makes a fair response, even though a double application of the minerals is made, as well as a normal ration of nitrogen.

Comparative Effects of Lime and Green Manure Combined. —In this group are plots 23, 24, 25, 26, 27 and 28. The statement of results is as follows:

Plot 23	K_2PGL	124
" 24	$\frac{1}{2}(K_2PN)GL$	125
" 25	$(K_2PN)GL$	121
" 26	$2(K_2PN)GL$	129
" 27	$3(K_2PN)GL$	128
" 28	$4(K_2PN)GL$	123

The results indicate that green manure, even with lime, has not benefited the trees and vines. On none of the green manured plots have the results reached by the normal ration been equalled. The future experience of the Experimental Farm may reverse this judgment.

General Conclusions.

The general conclusions from the above study of experimental results, bearing in mind that we are dealing now with growth of young plants only, is that, the normal ration established by the Committee, appears to be, for very young trees and vines, substantially correct, though an increase in the phosphoric acid seems justified. Under the conditions specified equal quantities of potash in the different forms indicate an agricultural value of the first rank for sulphate, 2nd, muriate; 3rd, double manure salt; 4th, carbonate of potash-magnesia; 5th, kainit.

V.

THE RESULTS ON INDIVIDUAL SERIES.

Having compared the results on the whole Fruit Farm taken collectively, we now consider each series separately, in order that the effect on different kinds of fruit may be noted. It may be necessary to repeat once more that these results are relative only, and the recorded facts of this Report are more for purposes of future comparison than for the immediate use of planters. The method of fertilization most desirable for young trees and vines not yet in bearing, may be shown here plainly; but, the amounts for actual fruit production remain to be shown by the next few years' experimentation on this farm.

Series I.—Small Fruit.

This series is divided into three groups, viz.: *a*,. Strawberries, *b*, Blackberries, *c*, Raspberries. The blackberries and raspberries were planted March 5, 1896. So few of the plants of either lived that it was found necessary in the fall to dig up the remaining plants and reset. This was done January 1, 1897.

STRAWBERRIES—LADY THOMPSON.

The strawberries were planted in March, 1896, by the hill sys-

tem. No fruit was produced the first year, but records were kept of the average growth, height and spread of plants, length of runners, together with observations on the color of foliage, vigor of plants, and insect and fungous injuries. The vines were pruned of all runners, and the air-dried weight of them was determined in the laboratory of the North Carolina Experiment Station.

The fertilizer applications were made March 28th, at which time all the potash and phosphoric acid, and one-half of the nitrogen were applied; the remainder of the nitrogen was used June 1st. The results, necessarily incomplete from the short period of growth, are given in the following table. The analyses show the composition of the dry matter of the air-dry prunings.

Relative Vigor and Analysis of Runners of Strawberry Series.

Plot.	Fertilizer.	Observed Vigor.	ANALYSIS OF AIR-DRY RUNNERS.		
			Per cent Phos. Acid	Per cent Potash.	Per cent Nitrogen.
1	K_2PN	155	.71	2.78	1.17
2	K_2PN	111	.71	2.66	1.27
3	K_2PN	200	.66	2.60	1.45
4	KP	155	.68	2.54	1.27
5	KN	178	.58	2.71	1.43
6	PN	211	.67	2.23	1.41
7	KPN	222	.60	2.30	1.37
8	O	100	.58	2.42	1.20
9	$K\frac{1}{2}PN$	200	.65	2.40	1.32
10	K_2PN	211	.61	2.73	1.33
11	K_3PN	155	.65	2.92	1.22
12	$KP\frac{1}{2}N$	133	.61	2.45	1.29
13	KP_2N	167	.65	2.75	1.21
14	KP_3N	189	.72	3.06	1.50
15	$KPN\frac{1}{2}$	125	.62	2.55	1.17
16	KPN_2	150	.63	2.42	1.41
17	KPN_3	133	.63	2.70	1.56
18	K_2PG	142	.73	2.78	1.51
19	$2(K_2P)G$	125	.77	3.18	1.61
20	$2(K_2P)NG$	150	.73	3.03	1.64
21	O	100	.68	2.21	1.41
22	K_2PNL	142	.68	2.57	1.63
23	K_2PLG	142	.68	2.67	1.38
24	$\frac{1}{2}(K_2PN)GL$	117	.68	2.57	1.47
25	$(K_2PN)GL$	117	.72	2.82	1.47
26	$2(K_2PN)GL$	117	.73	2.73	1.27
27	$3(K_2PN)GL$	142	.70	3.20	1.68
28	$4(K_2PN)GL$	133	.70	3.30	1.78
29	K_2PN (*Sul*)	142	.68	2.76	1.54

The period of growth is too short to warrant any observation on the above results.

Series II.—Grapes.

The grape vines were set out March 9, 1895. One-half (eastern) of the plot was planted in Delawares, the other half in Niagaras. The Delaware section of one-twentieth acre contains five rows, and seven plants to the row, or 35 to the plot, or 700 to the acre. The Niagara section contains five rows of six plants each, or 30 to the plot, or 600 to the acre. The Delaware rows are 9.8 feet apart and 4.9 feet from the roadway, with vines 6.35 feet apart in the rows, and 3.17 feet from the roadway. The Niagara rows are 9.8 feet apart and 4.9 feet from the roadway, with vines 7.41 feet apart in the row and 3.70 feet from the roadway.

The fertilizer application in 1895 was one-half normal; in 1896, three-quarters normal, applied over the whole area. The potash, phosphoric acid and one-half the nitrate of soda were applied March 26th and 27th; the remainder of the nitrate of soda was applied May 16th.

The plants were cut back to the ground in the spring of 1896, and pruned according to strength in 1897. Plots 1, 2, and 3, which received only applications of potash, phosphoric acid and nitrogen, respectively, in 1895, were reset in the spring of 1896. These were cut back to the ground in 1897, and the prunings represent the entire growth in 1896. No fruit was produced in 1896, and consequently the average growth as shown by the prunings, computed on basis of a full stand, and the observed vigor, are the only means of comparing the effects of the different fertilizer combinations. The vines are in fine condition, and interesting and valuable results may be expected in the near future. The analyses of the prunings are given in the following table:

Table Showing the Analyses of the Grape Prunings.

Plot.	Fertilizer.	Delaware.			Niagara.		
		Phos. Acid P_2O_5.	Potash K_2O.	Nitrogen N.	Phos. Acid P_2O_5.	Potash K_2O.	Nitrogen N.
1	K_2PN	.74	2.24	3.17	.68	2.38	2.71
2	K_2PN	.70	2.02	2.80	.71	2.27	2.64
3	K_2PN	.64	2.14	2.86	.67	2.46	2.80
4	KP	.66	2.49	2.86	.76	2.55	2.65
5	KN	.67	2.45	2.64	.67	2.45	2.71
6	PN	.69	1.80	2.64	.72	1.95	2.57
7	KPN	.72	2.15	2.70	.71	2.75	2.58
8	O	.62	1.73	2.42	.66	2.32	2.53
9	$K_{\frac{1}{2}}PN$	.75	1.99	3.37	.67	2.64	2.54
10	K_2PN	.56	2.26	2.51	.68	2.32	3.00
11	K_3PN	.63	2.52	2.49	.62	2.84	2.46
12	$KP_{\frac{1}{2}}N$	.58	2.18	2.66	.72	2.86	2.50
13	KP_2N	.72	2.15	3.08	.71	2.61	2.44
14	KP_3N	.73	2.11	2.52	.73	2.49	2.53
15	$KPN_{\frac{1}{2}}$	.71	2.23	2.63	.71	2.57	2.76
16	KPN_2	.68	2.05	2.64	.75	2.73	3.04
17	KPN_3	.69	2.23	2.56	.75	2.31	2.76
18	$(K_2P)G$	.72	2.24	2.48	.81	2.90	2.67
19	$2(K_2P)G$	.69	2.86	2.50	.79	3.16	2.52
20	$2(K_2P)NG$	.67	2.44	2.64	.79	2.97	2.61
21	O	.66	1.67	2.56	.72	2.17	2.28
22	K_2PNL	.63	2.35	2.44	.65	2.35	2.78
23	K_2PGL	.71	2.22	2.81	.73	2.90	2.24
24	$\frac{1}{2}(K_2PN)GL$	.61	2.04	2.50	.71	2.36	2.65
25	$(K_2PN)GL$	.69	2.67	2.69	.73	2.69	2.69
26	$2(K_2PN)GL$	.67	2.42	2.51	.73	3.05	2.37
27	$3(K_2PN)GL$	.71	2.77	2.80	.76	3.24	2.98
28	$4(K_2PN)GL$	.69	2.30	2.88	.77	3.18	2.61
29	K_2PN(*Sul*)	.58	2.81	2.38	.76	2.90	2.86

The following table gives the results on each of the plots of both varieties, based on weight of prunings and observed vigor.

Table Showing the Relative Weight of Prunings and Observed Vigor for all of the Plots of the Grape Series.

Plot.	Fertilizer.	Weight of Prunings.			Observed Vigor.
		Delaware.	Niagara.	Average.	
1	K_2PN	77	103	90	100
2	K_2PN	114	125	119	100
3	K_2PN	106	108	108	100
4	KP	109	110	110	140
5	KN	133	130	132	140
6	PN	135	143	139	160
7	KPN	205	153	179	140
8	O	100	100	100	100
9	$K_{\frac{1}{2}}PN$	198	138	168	140
10	K_2PN	184	152	168	160
11	K_3PN	193	200	197	160
12	$KP_{\frac{1}{2}}N$	144	150	147	140
13	KP_2N	242	243	243	180
14	KP_3N	242	227	235	180
15	$KPN_{\frac{1}{2}}$	110	112	111	100
16	KPN_2	152	172	162	129
17	KPN_3	153	192	173	129
18	$(K_2P)G$	135	161	148	100
19	$2(K_2P)G$	148	134	141	114
20	$2(K_2P)NG$	156	148	152	129
21	O	100	100	100	100
22	K_2PNL	194	161	178	143
23	K_2PGL	125	158	122	114
24	$\frac{1}{2}(K_2PN)GL$	166	151	159	114
25	$(K_2PN)GL$	171	166	169	100
26	$2(K_2PN)GL$	165	165	165	114
27	$3(K_2PN)GL$	171	190	181	114
28	$4(K_2PN)GL$	186	210	198	100
29	K_2PN(*Sul*)	162	200	181	143

In the above table no distinction was made between the two varieties of grapes in estimating the observed vigor.

The effects of the various combinations of fertilizers refer to the development of a young vineyard, not to one of bearing age. Plots 4 and 5 averaged 121, plots 4 and 6 averaged 125, plots 5 and 6 averaged 136. Increasing the quantity of potash was without effect for the double ration; but made a considerable gain for the triple ration while the reduced ration fell below normal. Phosphoric acid showed a loss by reducing the normal ration and a very material gain by increasing it; the triple ration seems to have gone beyond the limit of possible increase of efficiency. Nitrogen shows a loss for a reduction of the normal ration and no gain for an increase. The indications are that both the potash and phosphoric acid in the normal ration could be increased to advantage.

Lime shows a slight benefit when used with muriate of potash. It does not, however, equal the sulphate of potash plot. Green manuring without lime shows a steady loss, even when a normal ration of nitrogen is given and the mineral fertilizer ration increased. Green manuring with lime shows gains as the mineral fertilizers are increased; but do not equal the normal plot, excepting plot 28, with large quantities of potash, nitrogen, and phosphoric acid.

Series III.—Peaches.

The original trees of the peach series were so far damaged by insect depredations that it was deemed advisable to renew the whole series. This was accordingly done, and in March, 1896, the entire series of peach plots were put out in Elberta trees. These trees were one year old and remarkably even. The growth during 1896 was in every way most satisfactory. The peach trees received one-fifth normal application of fertilizer, the application being made in a circle of three feet radius around the trees. The potash and phosphoric acid and one-half the nitrate of soda were applied March 21st, and the remainder of the nitrate of soda June 1st.

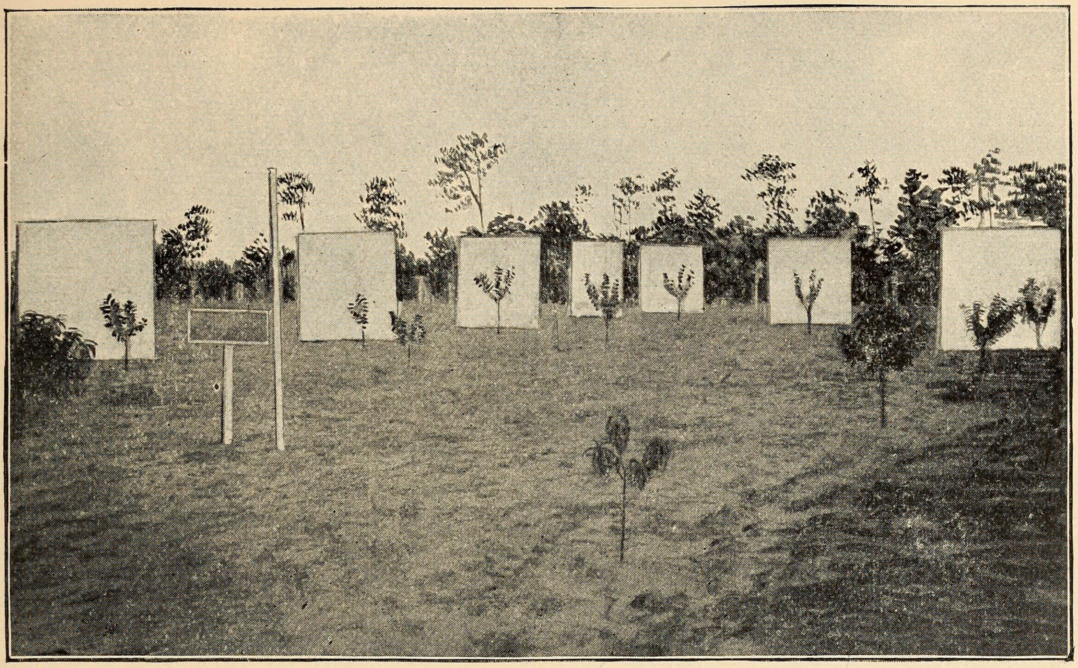
The following table gives the efficiency of the different combinations of fertilizer, both by a comparison of the weights of prunings and also the observed vigor of the growing trees. The average height of the trees on October 7th is also given.

Table Showing the Effect of the Different Combinations of Fertilizers on the Peach Series.

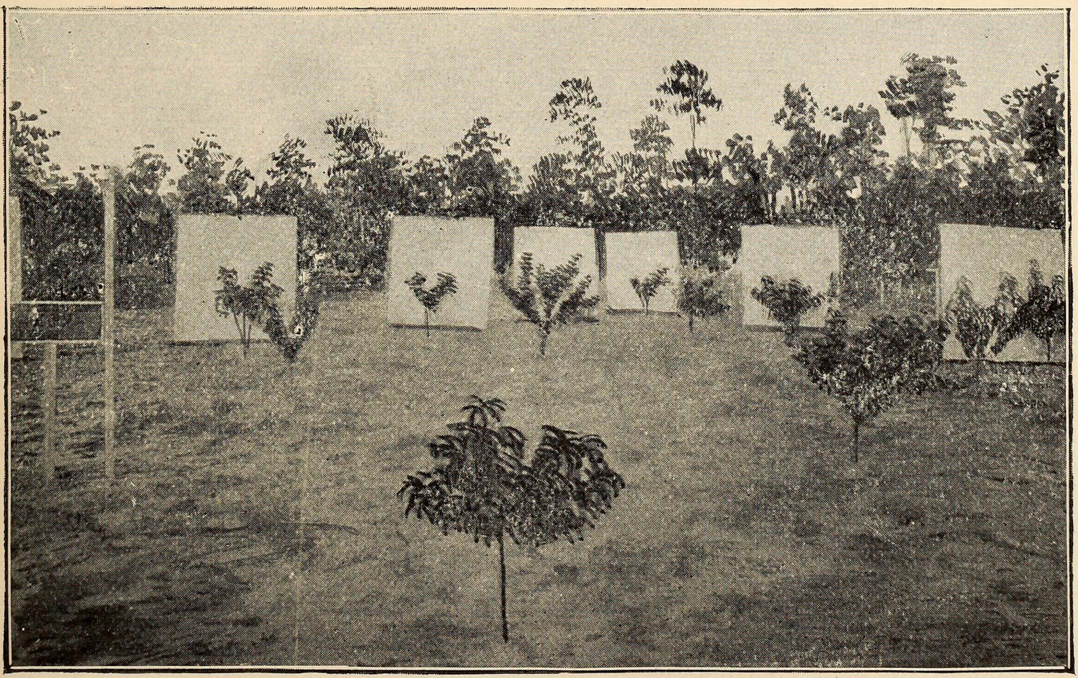
Plot.	Fertilizers.	Vigor.	Prunings	Height of Trees. Inches.
1....	K_2PN	175	105	46.2
2....	K_2PN	200	114	46.3
3....	K_2PN	150	97	36.5
4....	KP	175	99	34.5
5....	KN	175	133	32.9
6....	PN	200	135	40.5
7....	KPN	225	182	43.4
8....	O	100	100	35.3
9....	$K\frac{1}{2}PN$	174	130	40.1
10....	K_2PN	150	156	40.7
11....	K_3PN	200	136	34.8
12....	$KP\frac{1}{2}N$	200	134	40.5
13....	KP_2N	250	202	43.5
14....	KP_3N	225	212	44.0
15....	$KPN\frac{1}{2}$	140	138	38.9
16....	KPN_2	190	125	42.9
17....	KPN_3	180	160	44.9
18....	$(K_2P)G$	140	105	39.0
19....	$2(K_2P)G$	140	121	45.9
20....	$2(K_2P)NG$	200	176	47.5
21....	O	100	100	36.2
22....	$(K_2P)NL$	200	155	49.0
23....	$(K_2P)LG$	160	98	43.5
24....	$\frac{1}{2}(K_2PN\,GL$	160	151	40.9
25....	$(K_2PN)GL$	180	123	44.4
26....	$2(K_2PN)GL$	180	125	47.3
27....	$3(K_2PN)GL$	190	150	49.1
28....	$4(K_2PN)GL$	200	165	52.2
29....	K_2PN(*Sul*)	180	134	42.8

The plots treated with varying quantities of potash indicate that the normal ration gave the best results, and that either reducing or increasing the ration without a corresponding increase in the other fertilizing ingredients was generally accompanied by a loss of efficiency.

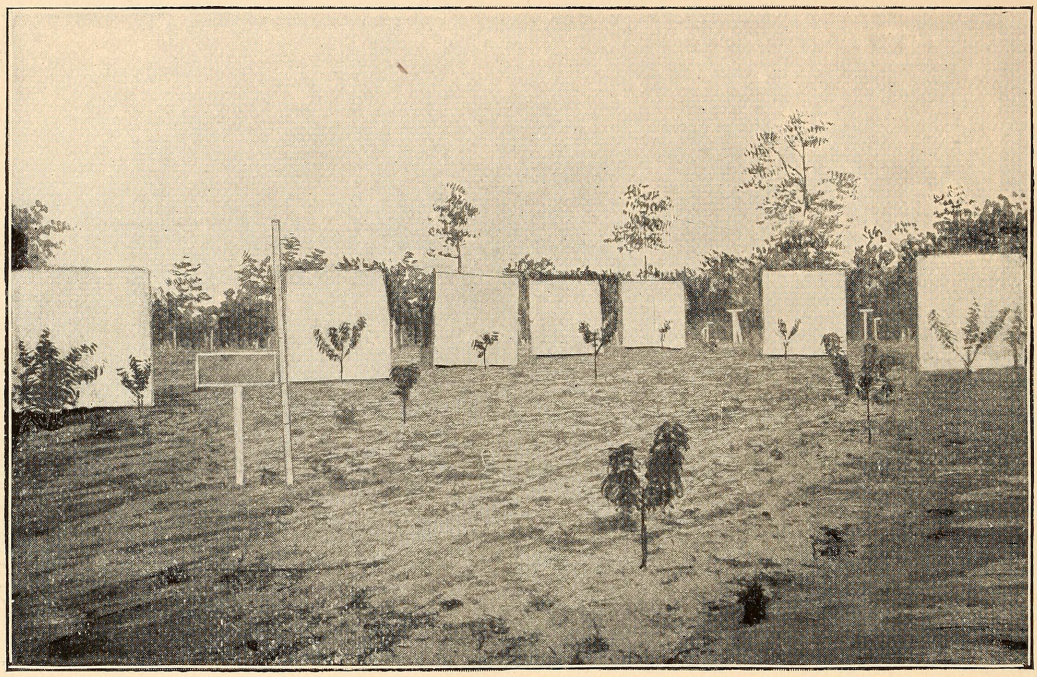
The changes in the phosphoric acid ration are in results not unlike those of the potash plots, excepting that increasing the ration gave appreciable gains. Increasing the nitrogen fails to accomplish a gain over the normal ration of plot 7. Lime seems to have made a slight gain, green manure alone fails to effect a gain unless the fertilizing ingredients are increased. In this case it is quite probable that the effect of green manuring has not been reached, and that the future records will make a very different showing.



Peaches, Fertilized with Potash (in form of Muriate), Phosphoric Acid and Nitrogen.



Peaches, Fertilized with Potash (in form of Sulphate), Phosphoric Acid and Nitrogen.



Peaches, Unfertilized.

Peaches, Fertilized with Potash, Phosphoric Acid and Nitrogen with Green Manuring and Lime.

Series IV.—Plums.

The plum trees were set out April 4th and 5th, 1895. Each plot consists of three rows of four trees each, or 12 to the plot. The rows are 16.33 feet apart and 8.16 feet from the roadway on the side of the plot. The trees are 22.22 feet apart in the row and 11.11 feet from the roadway. The trees received a one-fourth normal application of fertilizers, the application being made in a circle of 4 feet radius around the trees. The phosphoric acid, potash and half the nitrogen were applied March 20th and 21st and the remainder of the nitrogen on June 1st.

Table Showing the Effect of the Different Combinations of Fertilizers on the Plum Series.

Plot.	Fertilizer.	Vigor.	Prunings.	Height of Trees. Inches.
1	K_2PN	125	108	48.4
2	K_2PN	122	99	51.3
3	K_2PN	118	96	49.3
4	KP	125	112	47.1
5	KN	143	133	57.8
6	PN	165	135	68.8
7	KPN	145	220	67.7
8	O	100	100	44.8
9	$K\frac{1}{2}PN$	136	129	62.0
10	K_2PN	118	148	51.9
11	K_3PN	113	170	52.3
12	$KP\frac{1}{2}N$	139	140	61.5
13	KP_2N	130	201	57.3
14	KP_3N	136	201	63.8
15	$KPN\frac{1}{2}$	130	131	59.6
16	KPN_2	139	150	62.7
17	KPN_3	127	152	59.1
18	(K_2PG)	109	135	47.4
19	$2(K_2P)G$	101	134	49.9
20	$2(K_2P)NG$	135	125	53.7
21	O	100	100	53.7
22	K_2PNL	150	155	69.0
23	K_2PGL	120	125	49.0
24	$\frac{1}{2}(K_2PN)GL$	125	151	55.1
25	$(K_2PN)GL$	125	158	54.4
26	$2(K_2PN)GL$	122	133	54.4
27	$3(K_2PN)GL$	122	170	56.3
28	$4(K_2PN)GL$	117	158	51.1
29	$(K_2PN$(*Sul*)	142	162	67.8

The results indicate that for very young trees a complete fertilizer should be used on this soil, as the average of incompletely fertilized plots is only 127 as compared with 220 for the normal plot; the gain due to complete fertilization alone is nearly 73 per cent.

In this series lime makes a very good showing, even in some cases,

when compared with the sulphate of potash plot, No. 29. For growth as determined by prunings, for vigor, and also for height of trees on October 9th, lime makes a gain over plot 10, though the difference is not great. In this connection it is well to refer to the action of lime under conditions special to this series. The land was broken in 1895 and the plum trees planted the same year. In a natural condition the soil contained considerable organic matter as shown by the nitrogen contents of the soil. Lime applied to this soil, freshly broken by the plow, would in effect, make available very considerable quantities of fertilizing ingredients by the rapid decomposition of this organic matter. The effect of lime on plots planted in 1896 would very naturally show less decided results, as the organic matter had been more or less broken up in 1895, when the planting of the other series had not been made. As a matter of practical observation the benefits from lime applications, under normal conditions, such as existed in the plum series, were always clearly evident.

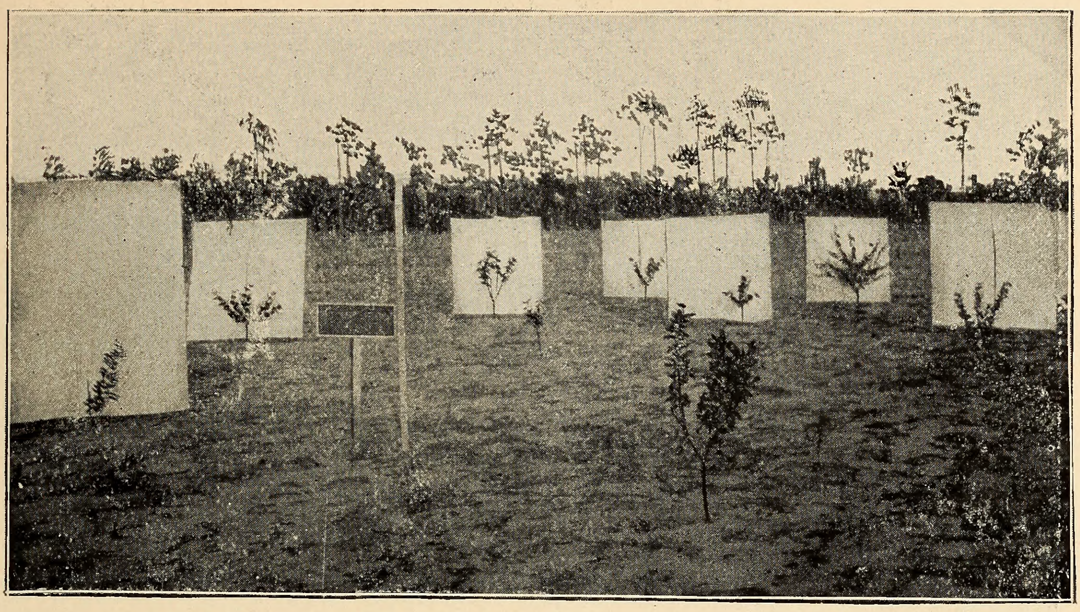
Series V.—Pears.

The pears (Kieffer) were set out in 1896, eighteen trees to the plot of one-tenth acre. The growth was small, and they were cut back to two or three buds, in pruning in March, 1897. The pears were given a one-fifth normal fertilizer application, the fertilizer being applied in a circle of three feet radius around the tree. The phosphoric acid, potash and one-half the nitrogen were applied March 23rd, and the remainder of the nitrate of soda June 2nd.

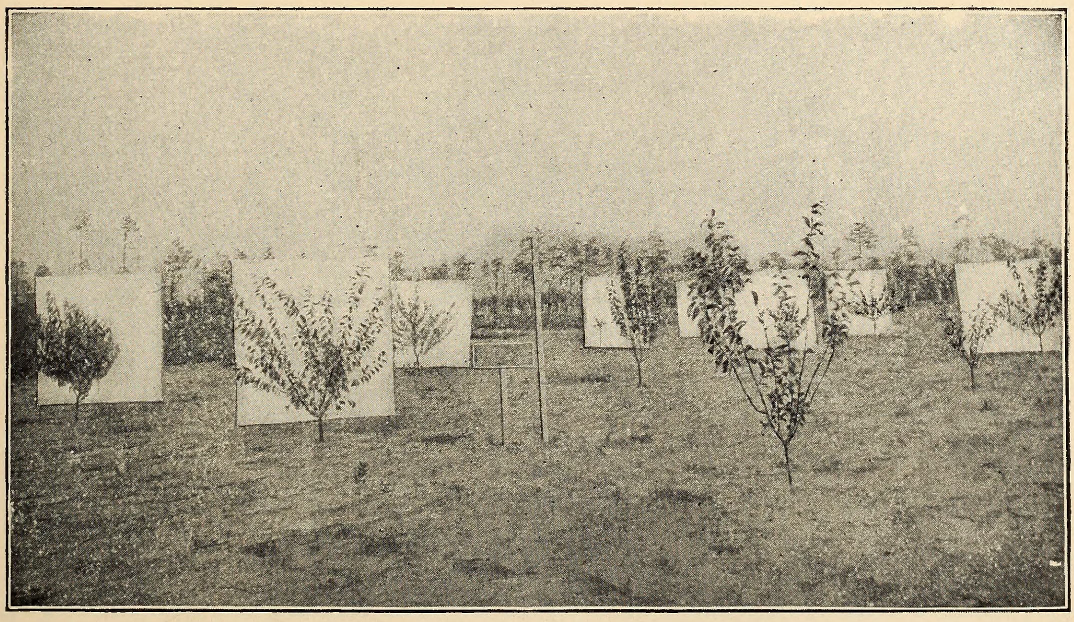
The growth for the year was very slight, and the quantity of total prunings so small that variations quite within the limits of reasonable plant growth would show wide gains and losses. Therefore conclusions can not be drawn from the observations of 1896. The observed vigor varied between narrow limits and the average height of the trees on October 8th varied only a few inches. The influence of the fertilizer applications could have been scarcely felt at the time the principal observations were made.

Series VI.—Apples.

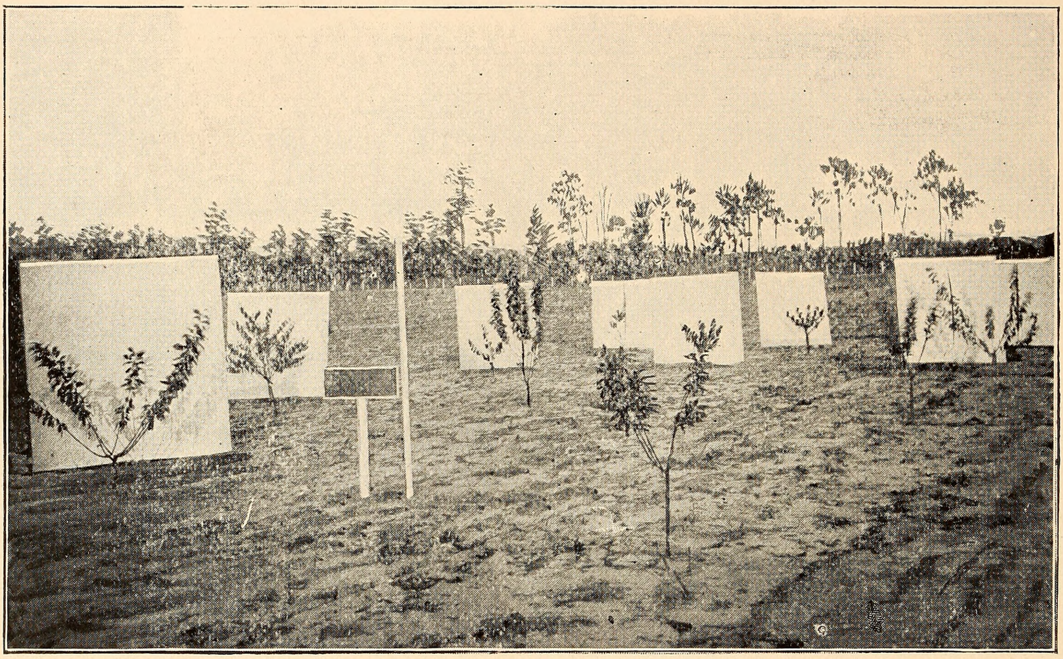
The apples were put out in March, 1896, with eight (8) trees to the plot. The growth made was not large and they were cut back to two or three buds at the February, 1897, pruning. The apples received a fifth of the normal application of fertilizers, the application being made in a circle of four feet radius around the trees. The potash, nitrogen and phosphoric acid were applied March 23rd and 25th, except that half the nitrogen was applied June 1st and 2nd.



Plums, Unfertilized.



Plums, Fertilized with Potash, Phosphoric Acid, Nitrogen and Lime.



Plums, Fertilized with Potash (in form of Muriate), Phosphoric Acid and Nitrogen.

Plums, Fertilized with Potash (in form of Sulphate), Phosphoric Acid and Nitrogen.

Table Showing the Effect of the Various Combinations of Fertilizers on the Apple Series.

Plot.	Fertilizer.	Vigor.	Prunings.	Height of Trees October 8.
				Inches.
1	K_2PN	129	133	34.7
2	K_2PN	129	117	37.4
3	K_2PN	129	133	36.6
4	KP	114	113	32.6
5	KN	114	135	32.7
6	PN	129	126	31.7
7	KPN	114	127	34.9
8	O	100	100	32.6
9	$K\frac{1}{2}PN$	129	147	38.0
10	K_2PN	114	138	32.0
11	K_3PN	114	152	34.4
12	$KP\frac{1}{2}N$	114	142	35.9
13	KP_2N	100	119	32.2
14	KP_3N	143	123	39.2
15	$KPN\frac{1}{2}$	129	138	35.3
16	KPN_2	114	150	37.0
17	KPN_3	129	145	34.1
18	$(K_2P)G$	100	139	32.1
19	$2(K_2P)G$	100	147	27.6
20	$2(K_2P)NG$	114	136	35.6
21	O	100	100	33.7
22	$(K_2P)NL$	114	111	35.0
23	$(K_2P)LG$	114	120	35.1
24	$\frac{1}{2}(K_2PN)GL$	114	136	35.5
25	$(K_2PN)GL$	100	173	29.6
26	$2(K_2PN)GL$	114	163	31.2
27	$3(K_2PN)GL$	100	170	27.6
28	$4(K_2PN)GL$	100	180	28.2
29	K_2PN (*Sul*)	143	153	44.9

The comparative effect of varying quantities of potash shows much irregularity. The normal ration gives a value of 127 while the one-half normal shows 147 and the double normal 138. The triple normal ration of potash gives the best results. The special phosphoric acid plots show results corresponding to those of the special potash plots. The nitrogen group shows, however, a steady gain as the nitrogen is increased, except for the triple normal ration which falls off slightly. In the earlier stages of the apple tree, the proportions of fertilizer best adapted to promote wood growth would seem to be KPN2. It is only fair to state that the normal ration plots (7) seem to have suffered from some injury at this time difficult to trace.

Lime shows no gains in this series, but green manuring makes a trifle better showing than usual. Doubling the standard ration (K2P) seems to have been accompanied by useful results, but adding the normal ration of nitrogen (plot 20) was without effect, possibly

enabling the green manure to make a more serious drain on the moisture supply. Green manure associated with lime was effective in this series, but only when the normal ration of nitrogen was added to the standard ration (K2P) of minerals. This combination seems to have proved beneficial, though there was no increase in the observed vigor, and the average height of the tree did not make a gain.

Series VII.—Chestnuts and Persimmons.

Chestnut seeds were planted in hills on March 4, 1896, at the rate of thirty-two (32) hills to the one-tenth acre plot. A great many of the seeds did not germinate, or the plants died during the hot summer weather after coming up. So few plants remained that it was decided in the fall of 1896 to set out one-half the chestnut plots with chestnut trees, and the other half with Japanese persimmons. This was done February 1, 1897. At this time the trees were planted twelve (12) to the plot—six trees being chestnut and six persimmon.

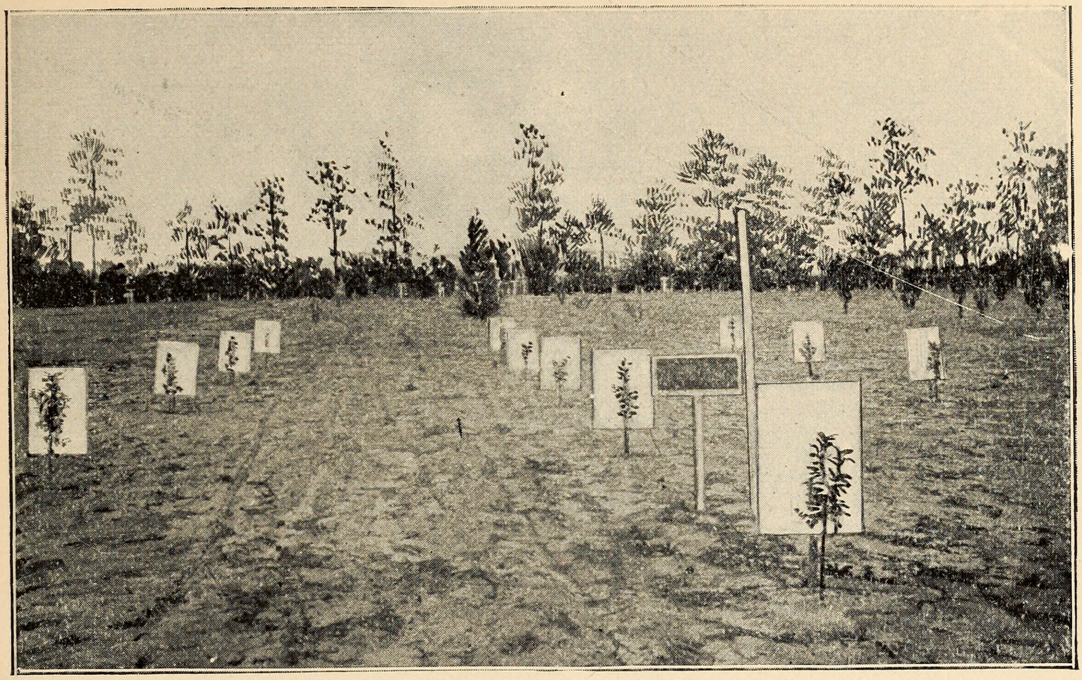
VI

GENERAL FIELD RESULTS FOR THE VEGETABLE FARM FOR 1896.

The full details of these experiments are given in the first part of this Report. The results are given in pounds per plot of the different forms of produce, which is graded according to the usual market requirements. Annual crops such as ordinary vegetables show inequalities of soil more quickly than slow growing plants, so that for the first few years, the results of these experiments must show many seeming contradictions. As the soil becomes more homogeneous these excessive variations may largely disappear. At this stage it is impracticable to prepare a summary of the results of the different series, as the diverse nature of the products do not permit of a concordant comparison. The full details of each series is given herewith.

Series I.—Sweet Corn.

The plots of this series were planted with onion seed in drills, on March 10th, and the normal amount of potash, and phosphoric acid, applied in the drills at the time of planting. Very few of the seed germinated, and on May 16th sweet corn, Station Hybrid variety, was planted in hills 3.27 by 3.7 feet apart and two stalks to the hill. This gave 182 hills to the one-twentieth acre plot. The corn was first cultivated on May 26th and had six cultivations after that date,



Pears, Unfertilized.

Pears. Fertilized with Potash, Phosphoric Acid and Nitrogen.

Apples, Unfertilized.

Apples, Fertilized with Potash, Phosphoric Acid, Nitrogen and Green Manuring.

with horse cultivator twice, and the remainder with a hand cultivator.

One hill of cow pease was planted between each hill of corn on July 20th but made poor growth and did not mature seed. The corn was severely affected with corn worms, and some of the ears had black smut. Corn (Boll) worms are very troublesome in the section in which the Experimental Farm is located.

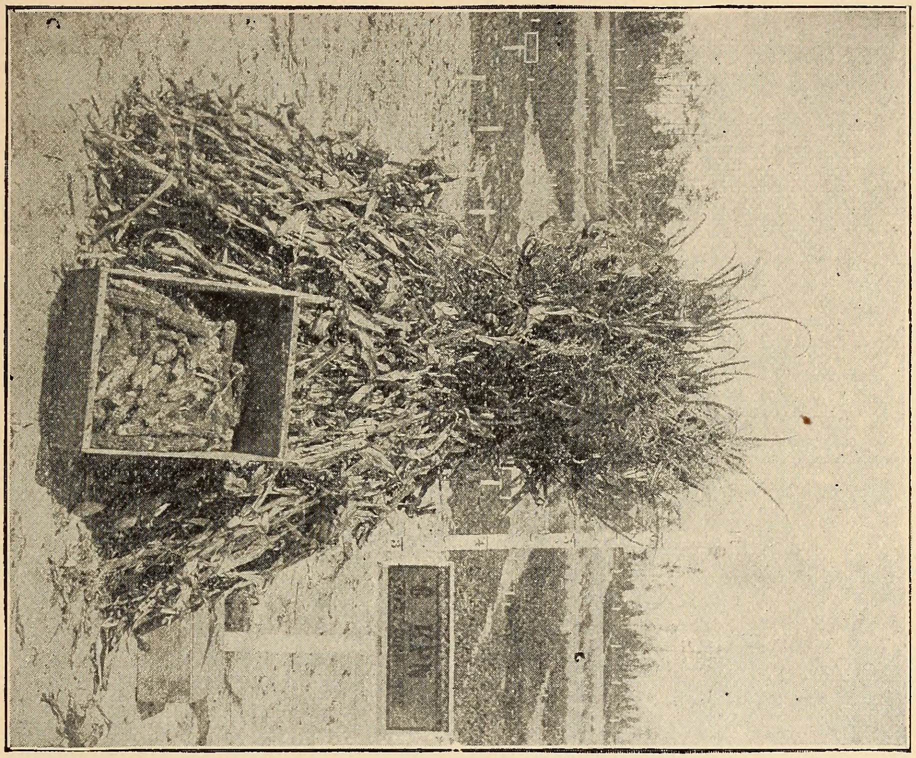
The phosphoric acid and potash of the fertilizer applications were applied to the onions March 17th to 20th, and one-half of the nitrate of soda at the same time; the remainder of the nitrate was applied June 27th. The corn was harvested August 24th, or three months and eight days after planting.

The yield of corn of the different grades, the weight of stover produced, and the total weight of ears of corn, calculated to a full stand are given in the following table:

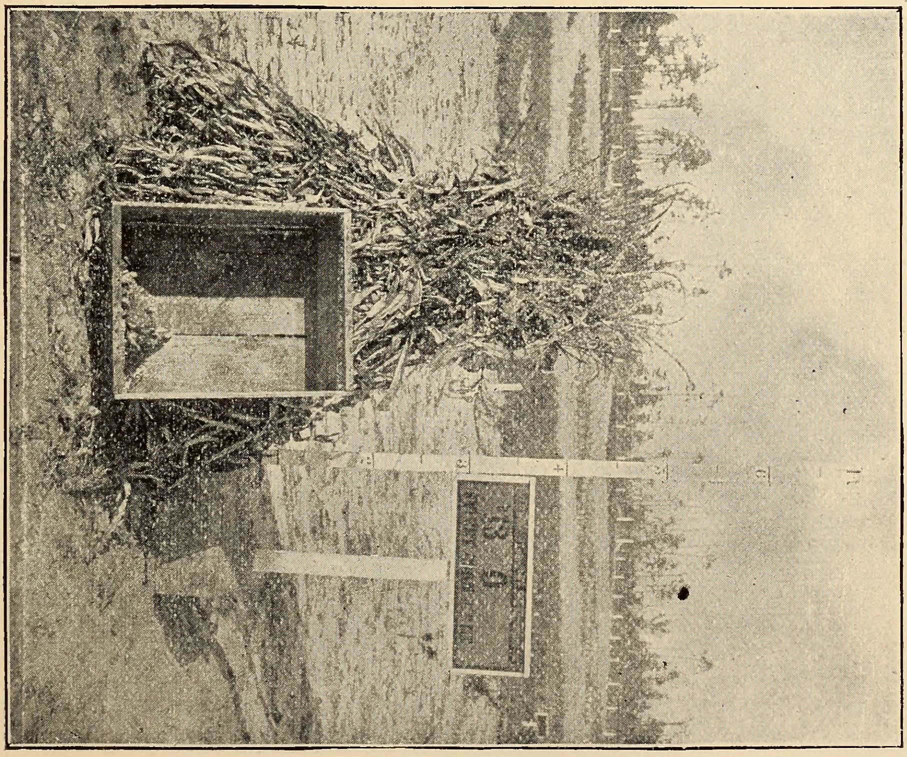
Table Showing Yield of Sweet Corn in Pounds Per 1-20 Acre Plot.—(Planted May 16th; harvested August 24th; Variety: Station Hybrid.)

No. of Plot.	Fertilizer.	First Grade. Weight of Ears.	First Grade. Number of Ears.	Second Grade. Weight of Ears.	Second Grade. Number of Ears.	Culls. Weight of Ears.	Culls. Number of Ears.	Total Weight of Corn Ears.	Stover.	Total Corn Ears Calculated to Full Stand
1	PNGL	33.1	136	12.3	93	7.2	81	52.6	91.5	55.2
2	KNGL	16.4	77	10.1	79	6.2	79	32.7	83.0	35.5
3	KPGL	6.7	30	5.8	51	4.0	77	16.5	91.0	18.5
4	KPNL	25.5	94	11.2	89	5.4	78	42.1	77.5	46.6
5	KPNG	17.9	85	13.2	116	4.9	81	36.0	76.5	38.7
6	KPN	17.5	88	10.6	92	5.6	67	33.7	74.5	37.5
7	O	2.1	11	2.4	26	1.9	57	6.4	54.5	6.9
8	KPNGL	13.2	70	7.8	87	3.3	76	24.3	68.5	26.1
9	*KPNGL	14.8	74	9.9	100	3.4	67	28.1	68.0	34.0
10	*KPNGL	11.9	52	8.9	80	3.4	64	24.2	70.5	28.5
11	*KPNGL	23.0	108	13.9	116	4.3	64	41.2	74.0	44.4
12	*KPNGL	15.4	84	10.9	105	3.6	58	29.9	66.0	34.0
13	O	----	----	.7	7	1.5	48	2.2	29.5	2.6
14	$K_{\frac{1}{2}}$ PNGL	17.6	89	12.8	107	4.0	56	34.4	64.5	41.8
15	$K_{\frac{3}{4}}$ PNGL	16.6	76	13.1	102	4.4	60	34.1	68.5	40.1
16	K_2PNGL	16.1	77	12.1	101	3.5	59	31.7	84.5	37.1
17	KP_2NGL	25.3	109	14.1	96	4.1	51	43.5	84.5	54.3
18	KPN_2GL	22.6	99	17.1	122	4.3	52	44.0	77.0	49.2
19	2(KPN)GL	30.7	123	16.1	112	4.6	57	51.4	90.0	58.4
20	3(KPN)GL	43.1	171	11.5	85	4.5	47	59.1	100.5	68.8

*In all the vegetable experiments, the potash in plots 9, 10, 11 and 12 is derived from sulphate of potash, kainit, sulphate of potash-magnesia and carbonate of potash-magnesia respectively.

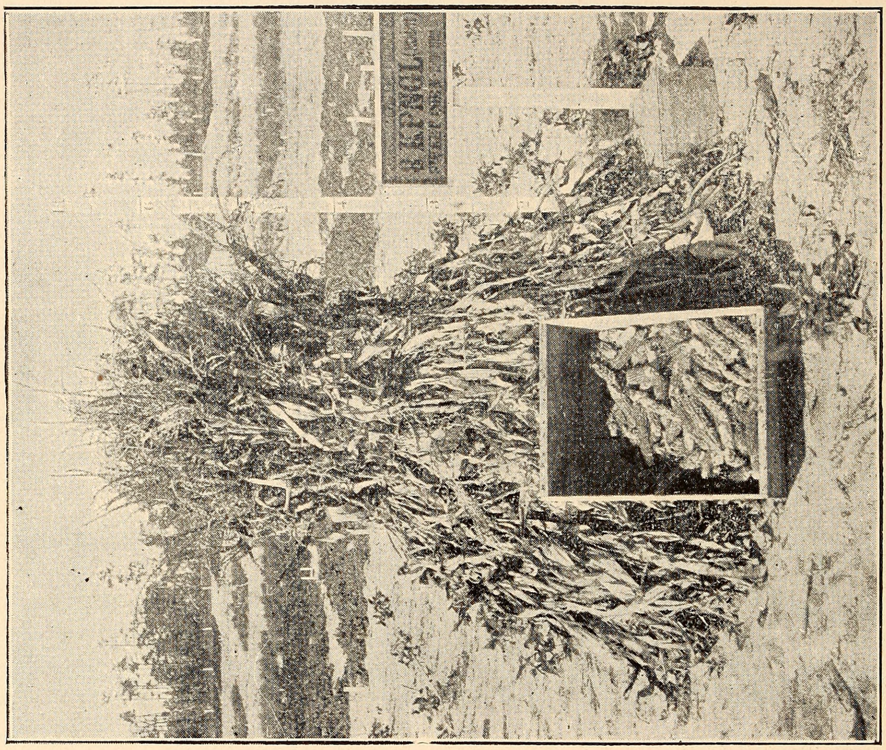


Sweet Corn, Fertilized wi h Potash, Phosphoric Acid and Nitrogen.



Sweet Corn, Unfertilized.

Sweet Corn, Fertilized with Potash, Phosphoric Acid, Nitrogen, Green Manuring and Lime, heavy application.



Sweet Corn, Fertilized with Potash, Phosphoric Acid, Nitrogen, Green Manuring and Lime, moderate application.

The total weight of ears calculated on basis of a full stand, on the unfertilized plots amounted to 6.9 pounds for plot 7 and 2.6 pounds for plot 13. The results of plot 7 will be taken as the basis for comparison, as plot 13 evidently suffered from accidental causes in undue proportion.

Incompletely fertilized plots 1, 2 and 3, gave results as follows, computed to a full stand:

Plot 1. PNGL	ears	55.2 lbs.,	stover	96.1 lbs.
" 2. KNGL	"	35.5 "	"	90.5 "
" 3. KPGL	"	18.5 "	"	101.9 "

The results show that a deficiency of nitrogen failed to reduce the stover percentage materially, and the deficiency of phosphoric acid failed to reduce the yield relatively. Potash seems to have increased the stover at the expense of the ears.

The results in total weight of ears with different forms of potash plots, 8, 9, 10, 11 and 12, were as follows:

	Pounds.	Ratio.
Plot 8. Muriate of potash	26.1	100
" 10. Kainit	28.5	109
" 9. Sulphate	34.0	130
" 12. Carbonate of potash-magnesia	34.0	130
" 11. Sulphate of potash-magnesia	44.4	170

The weights are so small that wide variations in ratios may be produced from purely accidental causes. The results on plot 11 are no doubt influenced in this manner.

The effect of different quantities of potash is shown by plots 8, 14, 15 and 16, given in weights of ears computed to a full stand:

	Pounds.
Plot 8. Normal ration	26.1
" 14. One-half normal ration	41.8
" 15. Three-quarters normal ration	40.1
" 16. Double the normal ration	37.1

These results are too discordant for comparison. While plots 14 and 15 seem to favor a reduction of potash, the gain of plot 16 over plot 8 reverses such deduction.

The effect of increasing the phosphoric acid ration is shown by

plot 17, which gives a gain for the increase of phosphoric acid; and the similar comparison for nitrogen (plot 18) also shows a decided gain.

The effect of increasing the applications of fertilizers is shown by plots 19 and 20, and may properly be compared with the results on plot 8. The results in weights of ears were:

Plot 8. Normal application	26.1	lbs.	100
" 19. Double application	58.4	"	224
" 20. Triple application	68.8	"	264

As compared with plot 7, the gains on plots 8, 19 and 20 were 278, 746 and 897 per cent. respectively. An important point is the fact that the quality of the product is improved by increasing the full ration of fertilizer applications as shown herewith:

	Per Cent 1st Grade.	Per Cent 2nd Grade and Culls.
Plot 8. KPNGL	54	46
" 19. 2(KPN)GL	60	40
" 20. 3(KPN)GL	73	27

The indications point to a lack of fertilizer in the normal applications.

The effect of lime is shown by comparing plots 4 and 6, indicating a very considerable benefit from the use of lime. Green manuring produced no effect in 1896 as it was the first year of the cultivation. Any benefits derived from this source can not appear in the results until 1897 and thereafter. The accumulation of humus in the soil by this means will probably reach useful proportions only after several years' work. Green manure with lime, is for this year, in effect merely a repetition of plot 4. They are all lime plots and further confirm the fact that lime plays a valuable part in the agricultural development of these soils.

The following table shows the anlyses of the water-free corn, and cobs, by plots:

Table Showing Percentage of Phosphoric Acid, Potash and Nitrogen in Water-Free Corn and Cobs.

	Fertilizer.	Corn Grain.			Cobs.		
		Phosphoric Acid.	Potash.	Nitrogen.	Phosphoric Acid.	Potash.	Nitrogen.
1	PNGL	.80	.68	1.88	.13	.38	.88
2	KNGL	.72	.54	1.84	.13	.43	1.08
3	KPGL	.90	.78	1.74	.26	.43	1.14
4	KPNL	.76	.74	1.33	.13	.35	1.12
5	KPNG	.84	.81	1.74	.20	.38	1.16
6	KPN	.83	.75	1.68	.19	.40	1.23
7	O	.96	.75	1.73	.25	.45	.89
8	KPNGL	.86	.76	1.69	.25	.48	1.22
9	KPNGL	.88	.79	1.75	.16	.32	.90
10	KPNGL	.90	.80	1.75	.19	.46	1.14
11	KPNGL	.75	.73	1.69	.13	.39	1.22
12	KPNGL	.79	.82	1.69	.16	.36	1.13
13	O	.93	.69	1.85	....	.60	1.29
14	$K_{\frac{1}{2}}$ PNGL	.87	.82	1.70	.16	.40	1.00
15	$K_{\frac{3}{4}}$ PNGL	.85	.80	1.70	.17	.36	1.09
16	K_2PNGL	.77	.76	1.67	.14	.40	.99
17	KP_2NGL	.85	.82	1.81	.15	.41	1.00
18	KPN_2GL	.78	.70	1.86	.13	.31	1.30
19	2(KPN GL	.69	.71	1.98	.11	.43	.86
20	3(KPN GL	.85	.70	1.96	.12	.42	.96

It is interesting to note that the unfertilized plots show very high percentages of phosphoric acid. Increasing the full ration of potash, phosphoric acid and nitrogen, showed a gain, in the grain, of nitrogen only; in the cobs a slight falling off is noted.

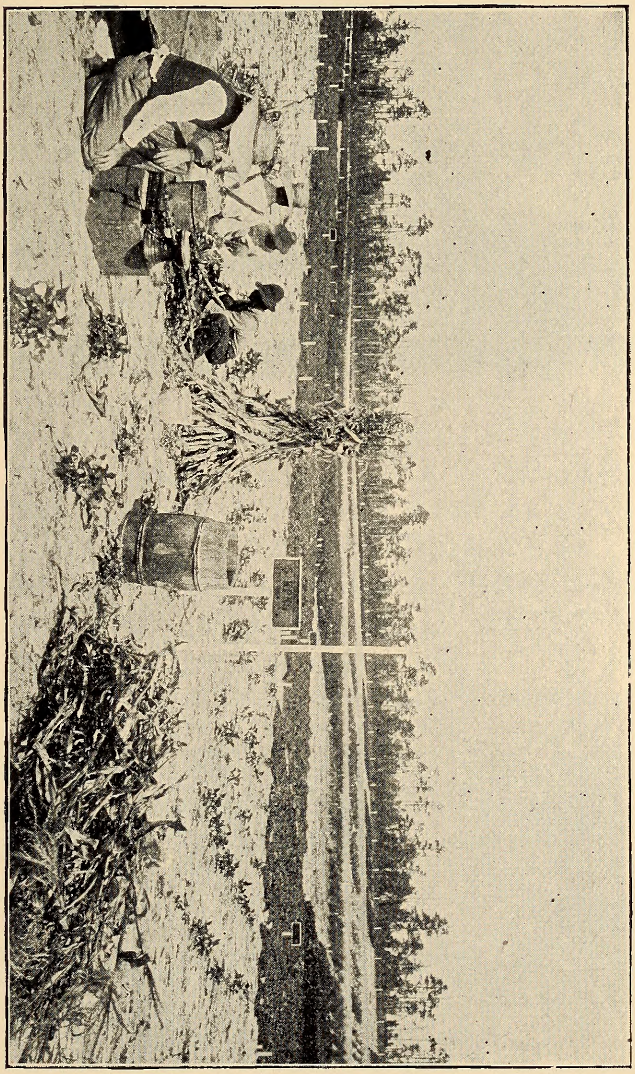
Series II.—Sweet Potatoes.

The sweet potatoes, White Southern Queen, were obtained from Newbern, N. C., and were bedded in cold frames April 28th. The ground was put in good condition before planting. Rows were opened and all the fertilizer application was put in the drill May 25th and 26th; a slight bed was made on this furrow and the plants set out on plots 1 to 14 May 26th, and on plots 15 to 20 June 4th. The rows were 2.8 feet apart and the plants 1.25 feet apart in the rows. This gave 612 plants to the one-twentieth acre plot. The weather was quite dry and the plants did not do well at first. The ground was cultivated once a week for three weeks after planting, the cultivation being level, and at the end of the fourth week, the rows were hilled with the turning plow. The stand was full.

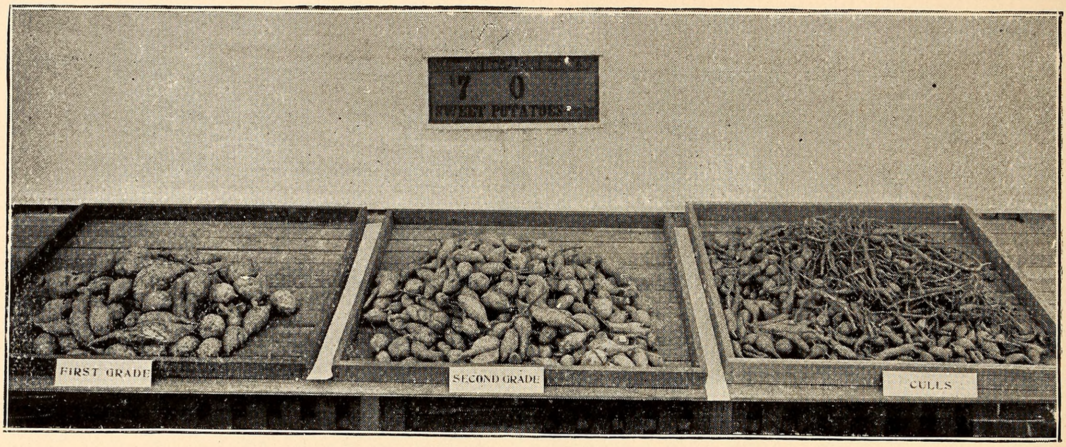
On October 17th the crop was harvested, with the results shown in the following table:

Table Showing Yield of Sweet Potatoes in Pounds Per $\frac{1}{20}$ Acre Plot.—(Planted May 25th to June 4th; Harvested October 17th.)

No. of Plot.	Fertilizer.	First Grade.	Second Grade.	Culls.	Total Weight Potatoes.	Weight of Green Vines at Time of Digging.	Weight of Roots.	Weight of Total Growth.
1	PNGL	106.5	105.0	61.5	273.0	438.0	38.0	749.0
2	KNGL	118.0	64.5	71.5	254.0	355.0	31.5	640.5
3	KPGL	139.0	64.0	88.5	291.5	392.0	38.0	721.5
4	KPNL	187.5	95.5	122.5	405.5	435.0	47.0	887.5
5	KPNG	223.0	108.0	108.5	439.5	442.0	71.5	953.0
6	KPN	238.5	115.5	74.5	428.5	433.0	88.0	949.5
7	O	39.5	60.0	49.5	149.0	199.5	41.0	389.5
8	KPNGL	169.5	89.5	79.5	338.5	340.5	58.0	737.0
9	KPNGL	159.5	82.5	51.5	293.5	245.0	63.0	601.5
10	KPNGL	130.5	82.5	54.5	267.5	280.5	58.0	605.0
11	KPNGL	109.5	60.5	69.5	239.5	257.0	68.0	564.5
12	KPNGL	99.5	58.5	63.5	221.5	202.0	55.0	478.5
13	O	1.5	23.5	28.5	53.5	70.0	33.5	157.0
14	K$\frac{1}{2}$PNGL	98.5	75.5	75.5	249.5	225.0	64.0	538.5
15	K$\frac{3}{4}$PNGL	90.5	84.5	89.5	264.5	198.0	57.0	519.5
16	K_2PNGL	112.5	93.5	79.5	285.5	222.0	51.5	559.0
17	KP_2NGL	120.5	99.5	94.5	314.5	220.0	60.0	594.5
18	KPN_2GL	76.5	68.5	67.5	212.5	249.0	64.0	525.5
19	2(KPN)GL	87.5	90.5	93.5	271.5	278.0	65.0	614.5
20	3(KPN)GL	108.5	80.5	83.5	272.5	312.0	98.0	682.5



Harvesting and Weighing Sweet Corn at the Experiment Farm,
Southern Pines, North Carolina.



Sweet Potatoes, Unfertilized.

Sweet Potatoes, Fertilized with Potash, Phosphoric Acid and Nitrogen.

The sweet potato series should have approached most nearly normal conditions of any of the series, as the soil conditions were approximately the same as the natural habitat of the plant. The unfertilized plots (7 and 13) show an average yield far below any of the fertilized plots. A fair comparison is as follows:

	Unfertilized.	Full Ration.	Gain.
	Lbs.	*Lbs.*	*Per Cent.*
First grade	20.5	238.5	1163
Second grade	41.8	115.5	276
Culls	39.0	74.5	191
Total weight	101.3	428.5	424
Vines	134.8	433.0	321
Roots	37.3	88.0	236
Total growth	273.4	949.4	322

The gain from fertilization is simply enormous. Though the analysis of the soil shows appreciable supplies of fertilizer ingredients within the reach of the root systems of the plants, the comparatively minute quantities of fertilizer applied seem to have worked wonders. For example, the fertilizer applied to the sweet potatoes contained but four pounds of potash to the plot; assuming that the root systems extended approximately over one-half of the area, which is quite probable, the potash existing naturally in the top soil of this area amounted to 51 pounds. That an application of but four pounds should have increased the product of marketable sweet potatoes by a large percentage is a striking illustration of the availability of soil fertilizer ingredients.

The results with different forms of potash salts (plots 8, 9, 10, 11, and 12), give the following data:

	First Grade.	Total Yield.
	Lbs.	*Lbs.*
Carbonate of Potash-Magnesia	99.5	221.5
Sulphate of Potash-Magnesia	109.5	239.5
Kainit	130.5	267.5
Sulphate of Potash	159.5	293.5
Muriate of Potash	169.5	338.5

The effect of increasing the amounts of potash, as shown by plots 8, 14, 15 and 16, is shown by the following table:

	First Grade.	Total Yield.
	Lbs.	*Lbs.*
Half normal ration	98.5	249.5
Three-quarters normal ration	90.5	198.0
Normal ration	169.5	338.5
Double normal ration	112.5	285.5

The percentage of marketable sweet potatoes (1st grade) and of 2nd grade and culls, of the total yield, were as follows:

	1st Grade.	2d Grade and Culls.
	Per Cent.	*Per Cent.*
Half normal ration	39	61
Three-quarters normal ration	46	54
Normal ration	50	50
Double normal ration	39	61

The returns from a profitable point of view are most favorable to the normal ration. While double the normal ration increased the production as compared with reducing the normal ration, the percentage of marketable sweet potatoes was reduced. The indications seem to point to the normal ration as the most correct proportions.

The effect of increasing the nitrogen is shown by plots 8 and 18, the items of which are as follows:

	Normal. KPNGL.	Double Normal. KPN_2GL.
	Lbs.	*Lbs.*
First grade	169.5	75.6
Second grade	89.5	68.5
Culls	79.5	67.5
Total	338.5	212.5
Vines	340.5	249.0
Roots	58.0	64.0
Total growth	737.0	325.5

The results seem to be unfavorable to increasing the nitrogen. The percentage of 1st grade sweet potatoes is greater on plot 8 than on plot 18, which would indicate a relative deficiency of mineral fertilizers.

By increasing the phosphoric acid, a better showing is made, as shown herewith:

	Normal. KPNGL.	Double Normal. KP_2NGL.
	Lbs.	*Lbs.*
First grade	169.5	120.5
Second grade	89.5	99.5
Culls	79.5	94.5
Total	338.5	314.5
Vines	340.5	220.0
Roots	58.0	60.0
Total yield	737.0	594.5

Of the total weight of sweet potatoes from plot 8, fifty per cent. was first grade, in plot 17, 38 per cent. The yield of the latter falls below the normal.

The effects of lime, plots 4 and 6, are noticeable in the fact that better returns are made than on plot 8 which received a full normal ration, but fall below plot 6 which received no lime.

Plot 6 returns 56 per cent. of its total weight of sweet potatoes in marketable form; plot 8, which is practically a lime plot 50 per cent.; plot 6 gives a gain in 1st grade over plot 8 of 41 per cent. In both plots about 45 per cent. of the total growth is composed of vines.

Analyses of the sweet potatoes were made in the laboratory of the North Carolina Experiment Station, for starch, glucose, sucrose, phosphoric acid, potash and nitrogen. The potatoes had dried out considerably before the analyses were made, and consequently the results could not be expressed in terms of the original potatoes as dug. The results are presented in the following table:

Table Showing Percentage of Starch, Glucose and Sucrose in Sweet Potatoes, and Phosphoric Acid, Potash and Nitrogen in Sweet Potatoes, Vines and Roots of Vines.—All on Water-Free Basis.

No. of Plot.	Fertilizer.	Sweet Potatoes.				Sweet Potatoes.			Sweet Potato Vines.			Roots.		
		Starch.	Sucrose	Glucose	Total Carbohydrat's	Phosphoric Acid (P_2O_5).	Potash (K_2O).	Nitrogen.	Phosphoric Acid (P_2O_5)	Potash (K_2O).	Nitrogen.	Phosphoric Acid (P_2O_5).	Potash (K_2O)	Nitrogen.
1	PNGL	--------	--------	--------	--------	.20	1.24	.84	.29	1.18	1.79	.21	.63	1.28
2	KNGL	68.58	6.71	10.89	86.18	.17	1.82	.91	.26	2.53	2.23	.19	1.20	1.35
3	KPGL	69.49	6.82	7.29	83.60	.16	1.64	.76	.26	1.96	1.77	.20	1.30	1.06
4	KPNL	70.72	7.29	8.69	86.70	.15	1.54	.71	.22	1.79	1.67	.19	.90	.94
5	KPNG	69.03	8.22	7.35	84.60	.16	1.67	.61	.27	2.31	1.48	.18	1.04	.65
6	KPN	70.78	7.86	7.86	86.50	.19	1.74	.54	.22	1.88	1.25	.20	1.03	.60
7	O	69.87	14.27	3.11	87.25	.26	1.45	.54	.31	1.46	1.74	.30	1.01	.63
8	KPNGL	70.99	9.31	6.85	87.15	.19	1.59	.59	.30	2.57	1.57	.20	1.08	.56
9	KPNGL	73.81	4.82	5.77	84.40	.19	1.38	.52	.24	2.30	1.73	.18	1.01	.64
10	KPNGL	69.89	11.59	9.23	90.71	.19	1.85	.52	.30	2.98	1.69	.20	1.02	.56
11	KPNGL	76.06	4.77	8.88	89.71	.19	1.38	.56	.27	2.57	1.37	.21	1.05	.60
12	KPNGL	74.64	4.14	9.04	87.82	.20	1.37	.62	.30	2.34	1.49	.20	1.00	.66
13	O	74.70	10.90	3.49	89.09	.28	1.05	.56	.42	1.74	1.61	.30	1.10	.64
14	$K_{\frac{1}{2}}$ PNGL	71.27	11.84	4.30	87.41	.19	1.09	.51	.33	1.70	1.59	.25	.83	.70
15	$K_{\frac{3}{4}}$ PNGL	72.57	9.32	7.10	88.99	.19	1.44	.59	.31	2.23	1.49	.20	.84	.68
16	K_2PNGL	70.92	6.60	8.99	86.51	.22	1.75	.46	.27	3.01	1.52	.19	1.25	.59
17	KP_2NGL	68.26	14.57	4.39	82.22	.18	1.38	.54	.29	2.30	1.47	.20	.88	.63
18	KPN_2GL	69.93	5.91	10.75	86.59	.18	1.60	.62	.29	2.33	1.81	.19	.99	.79
19	2(KPN)GL	75.40	3.29	9.45	88.14	.19	2.01	.71	.24	2.77	1.61	.16	1.12	.74
20	3(KPN)GL	72.88	11.57	4.41	88.86	.17	1.70	.75	.22	3.35	1.66	.18	1.48	.71
*4	KPNL	70.50	8.65	9.51	88.66	.16	1.43	.89	--------	--------	--------	--------	--------	------
†4	KPNL	63.79	10.18	4.27	78.24	.18	1.07	.87	--------	--------	--------	--------	--------	------

*Second Grade. †Culls.

It is interesting to note that on both the unfertilized plots, the phosphoric acid content of the roots, vines and potatoes, is the highest of the series. An increase in the potash ration shows also an increase in potash percentages in the sweet potatoes. As a rule, the same results are observed in increasing the other two fertilizing ingredients. Increasing the full normal ration, however, was not attended with noticeable changes.

Series III.—Cabbage.

The cabbage plants (Early Wakefield) were put out in rows 2.56 feet apart and the plants 1.56 feet distance in the row, March 10-17th. They were replanted March 16th. There were thus 560 plants to the 1-20 acre plot. The phosphoric acid and potash and part of the nitrogen were applied in the drill and bedded on before planting and the remainder of the nitrate of soda was put on April 11 and May 15. The cabbages were sprayed three times with kerosene emulsion to kill plant lice, and were cultivated once a week from time of planting to May 25th. The plants did not do well generally. The weather was hot and dry, and the plants were wilted and in bad condition most of the time. The results in consequence were irregular and are not presented.

Series IV.—Asparagus.

Good conditioned one-year-old asparagus roots (Palmetto Variety) were put out March 6th in rows 3.2 feet apart and the plants 2.02 feet distance in the rows. This gave 336 plants to the 1-20 acre plot. The roots were set about 12 inches in the ground and from April 15th to August 1st the plants, which came up about April 1st, were cultivated weekly with hand cultivator and the ground kept in good condition. The asparagus received only one-half normal fertilizer application in 1896, the first portion being put on March 6-17, and the second April 23rd and May 16th. The results of measurements of growth are shown in the following table:

Table Showing Average Growth of Asparagus in Inches.—(One-year old roots put out March 6th, 1896. Variety: Palmetto.)

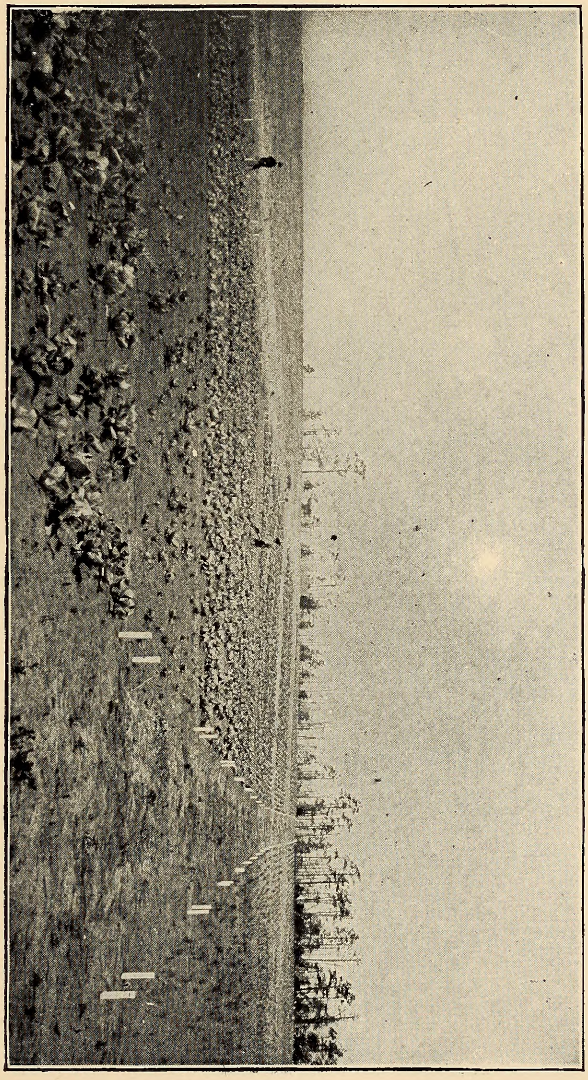
No. of Plot.	Fertilizer.	May 30.	July 14th. Average Number of Branches.	July 14th. Average Height.	August 8th.
1	PNGL	16.1	4.3	26.7	29.8
2	KNGL	12.9	4.3	21.7	22.1
3	KPGL	16.6	4.3	24.4	25.3
4	KPNL	17.8	5.8	31.4	25.1
5	KPNG	17.6	4.1	21.9	29.1
6	KPN	17.6	4.0	23.1	24.4
7	O	11.2	2.3	12.2	19.8
8	KPNGL	20.7	6.0	26.1	29.7
9	KPNGL	20.8	4.8	26.2	25.3
10	KPNGL	18.9	4.9	24.3	30.1
11	KPNGL	16.9	4.6	25.0	25.2
12	KPNGL	16.2	4.1	22.6	26.9
13	O	13.0	2.9	11.9	21.9
14	$K\frac{1}{2}PNGL$	14.4	4.3	21.1	27.3
15	$K\frac{3}{4}PNGL$	18.0	5.3	23.9	27.8
16	K_2PNGL	15.8	4.4	25.0	23.7
17	KP_2NGL	17.7	4.7	27.6	27.5
18	KPN_2GL	16.8	4.5	24.8	28.0
19	2(KPN)GL	17.2	4.8	24.5	27.9
20	3(KPN)GL	13.7	4.7	22.0	26.8

The development is too slight to justify comparisons for effects of the different combinations of fertilizers. Increasing the nitrogen (plot 18) made a slightly more rapid growth from May 30th to August 8th, but at the latter date, it was still below plot 8 in average growth.

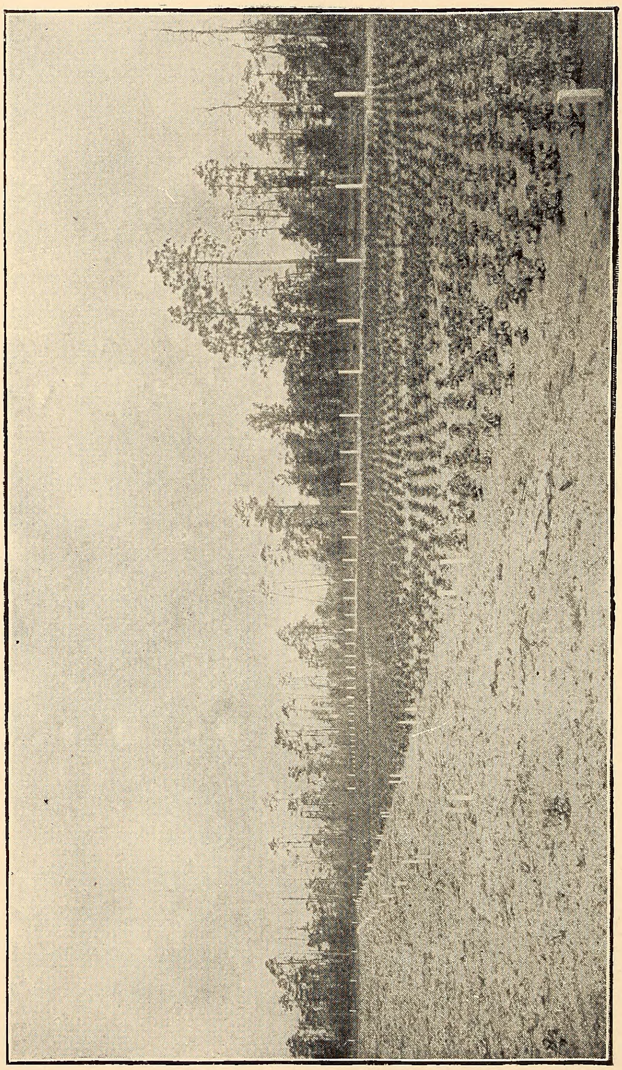
Series V.—Tomatoes.

The tomato seed (Livingston's Beauty Variety) were obtained of Geo. Tait of Norfolk, Va., and planted in cold frame February 18th. The plants were put out in checked rows 4.26x4.05 feet apart on April 4th. This gave 126 plants to the 1-20 acre plot. Only enough of these lived, on account of dry weather and perhaps other causes, to set two rows or one-third of each of the plots. Later in the season, seeds were planted in hills in the remaining four rows of the plots, but because of the lateness of the season and dry weather, these plants did very little good.

The phosphoric acid and potash of the fertilizer applications were applied in the hills at time of planting and the nitrate of soda then and on June 5th and 29th. The tomatoes were somewhat affected with rot and with worms. For these the plants were sprayed with Bordeaux mixture with two ounces Paris Green four times at intervals of ten days from time of blooming.



Showing Cabbage Series.



Showing Irish Potato Series, Vegetable Department,
Experimental Farm, Southern Pines, North Carolina.

The first ripe tomatoes were gathered on July 7th, and at intervals of two or three days until October 9th, when the remaining fruit was picked and record made of the yields. The results, however, owing to causes mentioned above are so irregular as not to permit of exact comparison and therefore are not presented. A sample of tomatoes and vines from plot 8 were analyzed with the following percentage results on dry-matter basis:

	Phosphoric Acid.	Potash.	Nitrogen.
Tomatoes—fruit	.98	6.84	3.86
Tomato plant	3.43	2.63	1.59

The analysis of the fruit shows seven times as much contents of potash as that of phosphoric acid.

Series VI.—Snap Beans.

The beans (Valentine) were planted April 9th to 10th, and were up April 15th. The rows were 2.56 feet apart. The fertilizer application was made in the drill. The weight of beans produced, and the phosphoric acid, potash and nitrogen percentages in the dry matter are shown in the following table:

Table Showing Yield of Snap Beans in Pounds per $\frac{1}{20}$ Acre Plot.

No. of Plot.	Fertilizer.	Weight, 1st Grade Beans (2 inches and over in Length).	Weight, 2d Grade Beans (under 2 inches in Length).	Total.	Per Cent of Water—Free Substance in Fresh Beans.	Composition of Dry Matter.		
						Per cent Phosphoric Acid (P_2O_5).	Per cent Potash (K_2O).	Per cent Nitrogen. (N).
1	PNGL	113.1	31.2	144.3	8.82	1.04	2.68	2.66
2	KNGL	104.1	29.5	133.6	9.52	1.06	3.56	3.40
3	KPGL	73.8	23.9	97.7	7.48	1.07	3.37	2.85
4	KPNL	131.6	30.1	161.7	8.29	1.18	3.46	2.86
5	KPNG	102.9	34.8	137.7	8.55	1.00	3.16	2.91
6	KPN	78.7	31.9	110.6	8.32	1.02	3.29	2.98
7	O	37.9	25.3	63.2	10.80	.96	2.68	2.77
8	KPNGL	84.1	25.7	109.8	8.83	.91	3.32	2.86
9	KPNGL	86.8	31.3	118.1	9.97	1.00	3.04	2.84
10	KPNGL	55.7	19.2	74.9	8.84	.98	3.49	3.22
11	KPNGL	119.0	27.9	146.9	9.62	.95	3.11	2.62
12	KPNGL	115.7	31.7	147.4	9.17	1.03	3.17	2.96
13	O	27.5	26.1	53.6	10.17	1.05	2.55	2.70
14	$K_{\frac{1}{2}}$PNGL	112.6	32.2	144.8	8.62	1.12	3.15	2.98
15	$K_{\frac{3}{4}}$PNGL	81.9	28.5	110.4	9.38	1.06	3.24	2.93
16	K_2PNGL	46.8	15.2	62.0	8.52	1.06	3.70	3.20
17	KP_2NGL	86.6	25.1	111.7	9.00	1.06	3.20	2.99
18	KPN_2GL	70.8	24.5	95.3	8.43	.90	2.88	2.91
19	2(KPN)GL	84.2	21.3	105.5	7.79	1.03	3.96	3.27
20	3(KPN)GL	43.4	12.2	55.6	8.51	1.01	4.10	3.12

The germination was so irregular, from various causes, that the results for 1896 are useless for purposes of comparison.

Series VII.—Cucumbers.

The cucumber seeds (White Spine variety) were planted in hills 5.1x5 feet apart on April 10th. This gave 85 hills to the 1-20 acre plot. The potash and phosphoric acid of the fertilizer application were applied in the hills just before planting the seed, and the nitrate of soda was put around the plants June 5th and 29th.

The first cucumbers were gathered on July 13th., and every three or four days from then to August 28th., the fruit was picked and records made of the yields of the different plots, which are shown in the following table:

Table Showing Yield of Cucumbers in Pounds per $\frac{1}{20}$ Acre Plot.

No. of Plot.	Fertilizer.	First Grade.	Second Grade.	Third Grade.	Orts.	Total.
1	PNGL	297.1	129.2	105.4	44.0	575.7
2	KNGL	37.0	16.9	22.1	87.2	163.2
3	KPGL	109.7	66.3	33.9	23.2	233.1
4	KPNL	323.1	120.1	58.9	26.0	528.1
5	KPNG	94.5	45.8	32.5	12.5	185.3
6	KPN	115.4	62.0	39.9	19.3	236.6
7	O	50.6	59.2	37.5	47.5	194.8
8	KPNGL	316.9	110.4	47.7	26.7	501.7
9	KPNGL	414.1	109.4	66.2	35.5	625.2
10	KPNGL	107.5	44.1	40.3	30.0	221.9
11	KPNGL	155.5	78.1	55.6	26.8	316.0
12	KPNGL	158.7	78.2	58.6	29.7	325.2
13	O	23.3	40.5	58.8	40.9	163.5
14	$K_{\frac{1}{2}}PNGL$	226.8	97.2	59.0	29.5	412.5
15	$K_{\frac{3}{4}}PNGL$	381.2	125.2	72.4	24.7	603.5
16	K_2PNGL	185.8	65.1	57.5	25.6	334.0
17	KP_2NGL	122.7	76.4	45.7	30.3	275.1
18	KPN_2GL	184.3	80.8	49.2	22.3	336.6
19	2(KPN)GL	265.7	158.1	74.8	39.5	538.1
20	3(KPN)GL	358.3	197.3	71.3	36.4	663.3

So many of the seed failed to germinate, probably due largely to the newness of the soil, that it is deemed unnecessary to discuss the results of 1896.

Samples of cucumbers, vines and roots were analyzed for phosphoric acid, potash and nitrogen and the percentage results on dry matter basis are presented below:

	Phosphoric Acid.	Potash.	Nitrogen.
Cucumbers, fruit	1.41	6.64	3.94
Cucumbers, vines	.54	2.70	1.24
Cucumber roots	.91	3.42	2.38

These analyses show that the fruit as well as the vines and roots of the cucumber are rich in potash and low in phosphoric acid.

Series VIII.—Irish Potatoes.

The seed potatoes (White Bliss variety) for planting were planted in rows 2.56 feet apart and 1.25 feet distance in rows on March 12th to 17th. This gave 680 plants to each 1-20 acre plot. The fertilizer application was made in furrows and a slight bed made on this before planting the potatoes. The heavy applications of fertilizers to plots 19 and 20 evidently affected the germination of the seed as 205 and 255 hills respectively of these plots failed to come up. Germination was much better on the others than on these two.

The potatoes were cultivated five times with hand cultivator at intervals of one week and then hilled with plow. Worms were kept off by spraying with Bordeaux mixture and Paris Green every eight days for one month after the plants were up some size. The potatoes were affected to some extent with early blight and scab.

The following table shows the yield of potatoes of the different grades as grown on the plots and calculated to a full stand:

Table Showing Yield of Irish Potatoes in Pounds Per 1-20 Acre Plot.

No. of Plot.	Fertilizer.	First Grade.	Second Grade.	Third Grade.	Total Weight of Potatoes.	Total Yield Calculated to Full Stand.
1	PNGL	90.2	105.7	23.0	218.9	220.8
2	KNGL	79.5	40.7	25.7	145.9	147.8
3	KPGL	69.2	68.5	41.0	178.7	180.5
4	KPNL	195.0	77.2	34.5	306.7	315.9
5	KPNG	120.5	89.7	63.2	273.4	280.4
6	KPN	124.7	60.7	54.0	239.4	249.8
7	O	6.7	27.0	52.7	86.4	90.2
8	KPNGL	169.7	67.5	28.7	265.9	275.5
9	KPNGL	168.7	77.2	36.0	281.9	295.7
10	KPNGL	151.7	54.5	23.0	229.2	276.8
11	KPNGL	179.2	64.0	33.2	276.4	296.6
12	KPNGL	134.5	80.5	32.7	247.7	256.7
13	O	6.0	28.5	64.2	98.7	103.8
14	$K_{\frac{1}{2}}$PNGL	189.7	76.0	43.5	309.2	319.3
15	$K_{\frac{3}{4}}$PNGL	172.5	65.5	31.5	269.5	282.2
16	K_2PNGL	194.7	43.2	19.7	257.6	302.0
17	KP_2NGL	220.7	84.7	24.5	329.9	344.4
18	KPN_2GL	207.5	74.5	21.0	303.0	377.8
19	2(KPN)GL	243.7	68.5	25.2	337.4	483.0
20	3(KPN)GL	268.5	66.2	22.7	357.4	571.6

The first noticeable point in these results is the great gain made by the fertilized plots over those receiving no fertilization.

The different forms of potash give results as follows:

	First Grade.	Total Yield.
	Per Cent.	*Lbs.*
Plot 8. Muriate	64	275.5
" 9. Sulphate	60	295.7
" 10. Kainit	67	276.8
" 11. Sulphate of potash-magnesia	65	296.6
" 12. Carbonate of potash-magnesia	54	256.7

The effect of potash is shown by plots 8, 14, 15 and 16, of which the following is a statement of the results:

	First Grade.	Total Yield.
	Per Cent.	*Lbs.*
Plot 8. Normal ration	64	275.5
" 14. Half normal ration	61	319.3
" 15. Three-quarters normal ration	64	282.2
" 16. Double normal ration	76	302.0

The results seem to indicate that an increase of potash was accompanied by useful results, in the gain in percentage of 1st grade potatoes.

Increasing the phosphoric acid is shown by the following statement:

	First Grade.	Total Yield.
	Per Cent.	*Lbs.*
Plot 8. Normal ration	64	275.5
" 17. Double normal ration	67	344.4

The effect of increasing the nitrogen is shown as follows:

	First Grade.	Total Yield.
	Per Cent.	*Lbs.*
Plot 8	64	275.5
" 18	68	377.8

In the case of both nitrogen and phosphoric acid, an increase pro-

moted the total growth, rather than the percentage of 1st grade, or marketable tubers. This would seem to indicate that an increase of all three of the fertilizer ingredients might prove an advantage. The statement of results from such an increase, is shown herewith:

Plot.	Formula.	First Grade.	Total Yield.
		Per Cent.	*Lbs.*
8	KPNGL	64	275.5
19	2(KPN)GL	72	483.0
20	3(KPN)GL	75	571.6

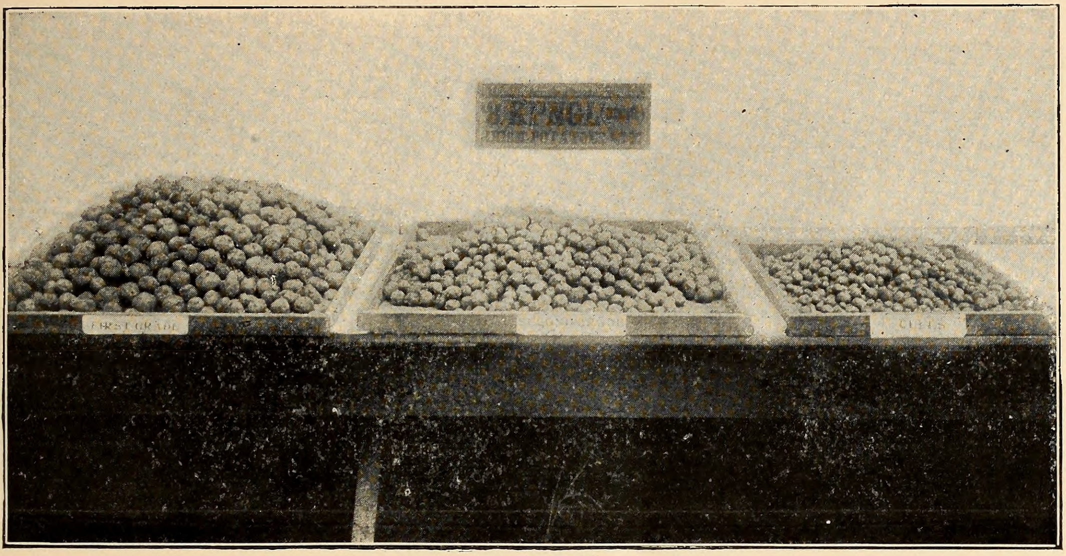
The effect of lime is shown by plots 4 and 6 as follows:

Plot.	Formula.	First Grade.	Total Yield.
		Per Cent.	*Lbs.*
4	KPNL	64	315.9
6	KPN	52	249.8

Lime naturally makes a good showing, as it has contributed to the supply of available fertilizer from its action on the organic matter in the newly broken up soil. Green manure could have no effect in 1896, as this is the first year of its use, and no results could accrue until a crop had been turned into the soil. All the "G L" plots are substantially lime plots for 1896.

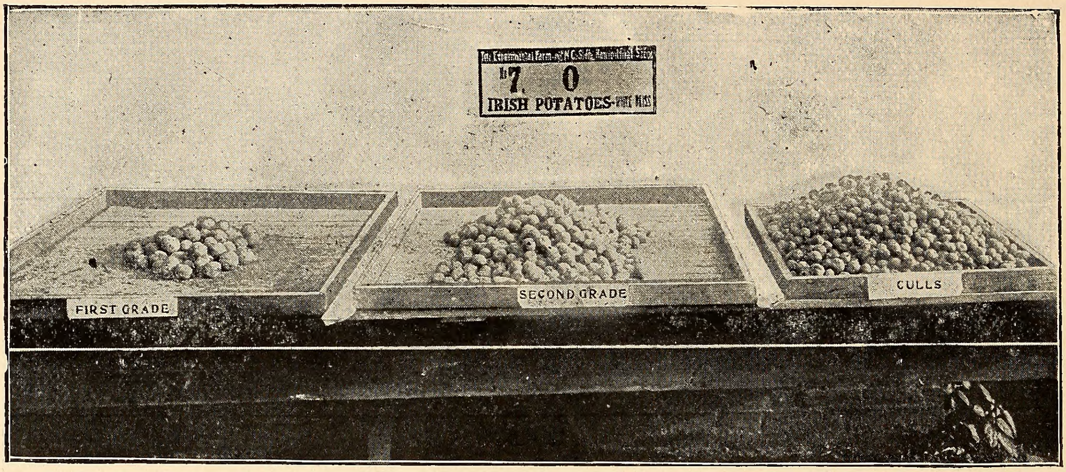
Starch was determined in the potatoes in the laboratory of the experiment station to see if the fertilizer combinations had influenced starch production. Phosphoric acid, potash and nitrogen were also determined in the potatoes and in the roots from the vines.

The following table gives the results of their analyses:

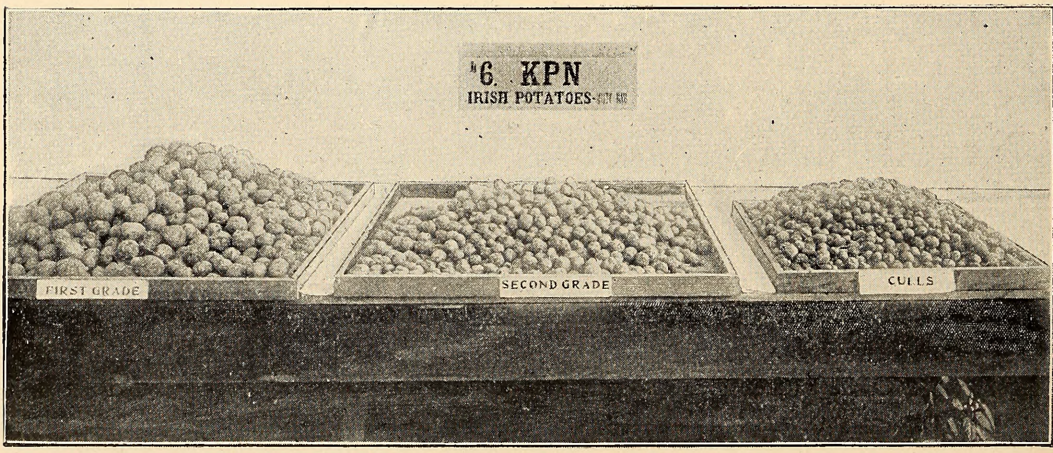


Irish Potatoes, Fertilized with Potash, Phosphoric Acid, Nitrogen, Green Manuring and Lime, moderate application.

Irish Potatoes. Fertilized with Potash, Phosphoric Acid, Nitrogen, Green Manuring and Lime, heavy application.



Irish Potatoes, Unfertilized.



Irish Potatoes, Fertilized with Potash, Phosphoric Acid and Nitrogen.

Table Showing Per Cent of Starch in Irish Potatoes and of Phosphoric Acid, Potash and Nitrogen in Irish Potatoes and Roots.

No. of Plot.	Fertilizer.	Dry Matter in Irish Potatoes.	Starch in Fresh Potatoes.	Starch in Matter of Potatoes.	Irish Potatoes. Dry Matter Basis. Phosphoric Acid (P_2O_5).	Irish Potatoes. Dry Matter Basis. Potash. (K_2O).	Irish Potatoes. Dry Matter Basis. Nitrogen.	Roots. Dry Matter Basis. Phosphoric Acid. (P_2O_5).	Roots. Dry Matter Basis. Potash. (K_2O).	Roots. Dry Matter Basis. Nitrogen.
1	PNGL	15.31	11.42	74.59	.64	2.16	2.21	.44	1.55	1.59
2	KNGL	14.44	10.07	69.76	.67	3.16	2.36	.50	1.17	1.78
3	KPGL	13.85	10.38	74.24	.80	3.32	1.82	.50	.74	1.81
4	KPNL	13.87	10.26	74.02	.64	3.33	2.25	.44	1.32	1.67
5	KPNG	14.70	10.90	74.18	.65	3.25	2.22	.59	1.70	1.66
6	KPN	13.88	10.47	75.45	.66	3.30	2.35	.50	1.40	1.62
7	O	12.21	9.17	75.07	.93	2.91	1.96	.38	1.11	1.54
8	KPNGL	13.00	9.50	73.10	.68	3.37	2.31	.45	.97	1.81
9	KPNGL	13.50	10.00	74.05	.65	3.07	2.40	.44	1.19	1.66
10	KPNGL	13.89	10.32	74.32	.69	3.48	2.31	.62	1.25	1.75
11	KPNGL	14.66	10.75	73.37	.68	3.13	2.28	.36	1.38	1.74
12	KPNGL	13.49	9.53	71.05	.66	3.28	2.53	.46	.89	1.51
13	O	10.42	7.80	74.82	.86	3.57	1.73	.44	1.44	1.55
14	$K\frac{1}{2}$ PNGL	12.07	8.84	73.17	.74	3.30	2.26	.42	1.21	1.56
15	$K\frac{3}{4}$ PNGL	11.84	8.53	71.96	.68	3.29	2.30	.38	.96	1.56
16	K_2PNGL	13.40	9.93	74.17	.60	3.60	2.17	.39	.81	1.80
17	KP_2NGL	12.98	9.63	74.22	.71	3.42	2.28	.38	.68	1.50
18	KPN_2GL	12.74	9.26	72.68	.68	3.28	2.64	.25	.60	1.31
19	2(KPN)GL	12.60	9.20	73.02	.63	3.72	2.40	.28	.78	1.36
20	3 KPN,GL	12.78	9.29	72.70	.75	3.69	2.38	.30	.63	1.28
*4	KPNL	11.19	8.72	77.90	.75	3.77	1.76	......	......	......
†4	KPNL	11.18	8.19	73.30	.79	3.99	1.93	......	......	......

*Second Grade. †Third Grade or Culls.

It does not appear that there is variation enough in the starch content of the potatoes grown on the different plots to warrant any conclusions, especially from one year's experiments. The determinations of fertilizer ingredients present no special features beyond the general observation of the high content of potash in both Irish and sweet potatoes and their vines. This observation is especially true when the percentages of phosphoric acid and potash are compared.

FUNGOUS AND INSECT RECORD FOR 1896

The fungous and insect record of the Experimental Farm for this, the second year of the undertaking includes, as was expected, many pests not observed during the first year. In the following paragraphs the various species are arranged according to their importance or noxiousness, under the heads of Fruit Plots and Vegetable Plots, respectively.

I.—Fruit Department.

Ants.—As was the case last year, ants were again the chief insect depredators. There were two genera of ants common. The smaller, more abundant and more injurious genus is *Solenopsis geminata, Fab.*, the other is *Camponotus Pennsylvanica,* by some authors called *Formica Pennsylvanica.* The first named lives in nests in the ground, the latter beneath the bark of trees and in the hollow of rotten stumps. *Solenopsis geminata* makes long and deep underground galleries. During the present year our whole reliance for preventing damage by ants was placed upon frequent tillage and the use of Paris green. The arsenite in this case was used as a liquid spray, in combination with the copper sulphate and lime, thus forming a combined insecto-fungicide. The following formula for a protective spray has been found most satisfactory for all varieties of fruit trees except peaches.

Copper Sulphate	4 pounds.
Paris Green	4 ounces.
Caustic Lime	4 pounds.
Molasses	1 gallon.
Water	1 barrel or 45 gallons.

In preparing the above mixture the sulphate was dissolved by suspending it in a sack in the barrel of water. The lime was slaked in the least quantity of water sufficient, all lumps were rubbed out, and then strained into the sulphate solution. The Paris Green moistened with sufficient water to wet it, was stirred into the mixture of lime and copper sulphate. Lastly the molasses was stirred in. The mixture was then ready for use, and was used at once as it soon deteriorates.

The above combination was very effective against all fungi which attack foliage and twigs, and against most gnawing insects. Ants seem, however, partially proof against arsenic in such doses. The experience of this year seems to indicate clean and frequent cultivation as the most satisfactory way of preventing serious damage from ants.

May Beetle.—The young shoots of peach and plum trees are often disbarked by some creature that has usually escaped the eyes of orchard men. The most common and injurious depredator of this class in the sand hill region of North Carolina is the so-called May beetle, *Lachnosterna tristis*. It is a medium-sized, dark brown beetle, appearing in this section during April and May. Its larval form is the common "white grub," so very destructive to lawns and pastures. These insects remain dormant in the ground during the winter and come forth about the time the shoots of the peach and plum begin to grow. They are nocturnal in their habits, and hence usually escape notice. The work of these beetles was apparent only on the plum plots. The spray applied for ants and fungous pests served effectually also for the May beetles.

Bud Caterpillar.—Excepting only the San Jose scale, the most threatening enemy of the peach tree in the sand-hill region is a small, pink-colored, yellow-headed caterpillar, the larval form of a Teneid moth (*Anarsia lineatella*). It attacks by preference trees under five years old. It does not in this section, so far as known, attack any other fruit tree than the peach. The parent moth of this pest was observed in the experimental plots during the preceding summer; but the replanting anew of the entire series of peach plots in the spring of 1896 destroyed all evidence of its work. The moth was seen again this year.

Snout or Curculio Beetles.—Much alarm has arisen among peach growers in this locality over the discovery on the trees of various species of "snout bettles"—beetles of the family *Rynchophora*. The most notorious pest of this family is the too well known curculio (*Conotrachelus nenuphar*). The latter insect, when it can not get plums, will attack the peach, and in early bearing orchards does more or less damage. The adult curculio beetle was captured in the experimental plots on both peach and plum; but as there was no fruit and will be none for two years yet, no damage has yet been done. Other beetles of the *Rynchophora* family were also captured, but in all cases these proved to be species known to attack only the pine, oak or hickory. Their appearance on our fruit trees was entirely accidental.

San Jose Scale.—The destructive pest, San Jose scale (*Aspidiotus perniciosus*) has so far failed to appear on the experimental plots, although there is a young infested peach orchard within a quarter of a mile.

Soft Scales.—Soft scale bugs of the genus *Lecanium* have appeared on the trees in both peach and plum plots. These scales did not cause damage enough to make it worth while to combat them by special measures.

Apple-tree Tent Caterpillar.—The apple-tree plots have suffered some from the tent caterpillar (*Clisiocampa Americana*). Where the tents of this insect were found on our plats they were at once removed by hand and stamped into the hot soil, which effectually stopped their activity. This insect prefers to feed upon the native persimmon. A few of these trees in an orchard would act as traps, from which the eggs and caterpillars may be easily removed.

The Black Aphis.—A few grape vines on several of the plats showed the terminal shoot colonies of the black grape aphide (*Aphis vitis*). In the present case all such shoots were promptly excised and stamped into the soil.

Leaf Hopper or Thrips.—The leaf hopper or grape-vine thrips is in all dry regions one of the most injurious pests of the vine. The adult bug has a triangular head, is slender, blackish, with two dark-red bands across the wings. The young ones resemble the parent form, but are whitish. They are very spry, and advance by a curious sidewise movement. They infest the under side of the leaves, which they puncture with their sharp snouts. By sucking away the sap they cause the leaf to die in small pin-head spots, giving the leaf a mottled appearance that is often mistaken for rust or some other fungous disease by non-scientific people. On our plots these insects were not numerous enough to make it worth while to combat them.

Leaf Roller.—The leaf roller of the grape vine (*Desmia maculalis*) is one of the worst pests in southern vineyards in dry regions. The parent moth is a blackish insect about one inch across the wings, with two white spots on each of its four wings. The caterpillar which does the damage is a very slender, green, slippery, red-headed insect. When disturbed it leaps with considerable agility and usually succeeds in slipping out of its case on to the ground. The insect passes the winter as a *pupa* in the leaves on the ground or those which remain attached to the vines. There are two broods each summer. The second brood is the one that does the most damage. On our plots wherever the leaf roller appeard it was promptly pinched between the thumb and finger.

Vegetable Department.

Potato Beetles.—On some of the Irish potato plots considerable damage was caused by the Colorado potato beetle (*Doryphora decemlineata*). On our plots Paris Green was used as part of the standard spraying mixture elsewhere mentioned. There is another species of potato beetle, *Epicauta cinerea*, sometimes called the "old-fashioned potato beetle," but more properly called blister beetle.

This is a long, slender, ash-colored insect. It is much more difficult to destroy than the Colorado beetle, and a heavier dose of arsenic must be used. The blister beetles were also seen on our plots, but were not abundant enough to do serious damage.

WIRE WORM.—"Wire Worms" are the well-known yellowish, flat, hard-bodied grubs always present in soil containing rotten wood and recently turned sod. These damage herbaceous crops in various ways, but most commonly by eating the seeds before these have sprouted and by gnawing tubers, roots, etc. Much of the so-called scab on potato tubers is caused by the gnawing of these worms. The remedy is to keep the soil of vegetable plots free as possible from rotten wood and sod. In our case the soil being new nothing could be done, and much injury resulted to the potato crop.

CORN OR BOLL WORM.—Considerable damage was noted in the sweet corn plots, caused by a large striped caterpillar eating into the tip of young ears. This insect eats the seeds formed near the tip of cob, and by furnishing an open way for the entrance of sparrows, ants and other foraging insects, causes indirectly even more damage than it does by its own voracity. The corn worm is the same insect species that eats into the bolls of the cotton plant. On corn the only effectual remedy is hand-picking from the tips of the young ears. Its presence in the ear is indicated by the prematurely withered and dead silk.

Fungous Diseases.

SHOT-HOLE DISEASE.—Both the peach and plum plots suffered severely from a fungous disease of the foliage which destroyed the vitality of the leaves in small spots. The dead parts of the leaves soon drop out leaving small, roundish holes, popularly called shot-holes. The cause of the disease on the peach trees was the fungus *Cercospora circumcissa.* The disease on the plum trees was due to another fungus, *Cylindrosporium Paduii.* An entirely satisfactory remedy for the disease on plum trees was found in the copper sulphate-lime-molasses mixture, for which the formula has already been given. This was applied once just before the buds burst and thereafter often enough to keep the foliage well covered with the chemicals. The disease on the plum plots was much more destructive. On every plot it was found that the Japaneses plums suffered more than the native varieties. In all plots Burbank suffered most and Wayland least.

The foliage of the peach tree is much more tender than that of the plum or any other fruit; this is especially apparent while the trees are young. As a rule, spraying young peach trees is apt to cause more damage than the disease it was intended to prevent.

When healthy, well-grown, young stock is planted there is no necessity for use of fungicidal sprays until the trees are of bearing age.

In the case of our plots no spraying was done during 1896. The damage caused by the fungus was not important.

Rust of Apple Leaf.—The leaves of the young apple trees, and to a lesser extent, the pear trees, showed the orange colored spots characteristic of the disease called "rust." This is caused by a parasitic fungus, *Roestelia pyrata*. The standard fungicide already mentioned was applied early and the leaves kept well coated. This prevented much damage being done.

Grape Mildew.—Mildew caused by the fungus *Peronospora viticola* was rather abundant on the leaves of the Niagara grape, but less so on the Delaware. The copper sulphate-lime-molasses mixture was a satisfactory remedy.

Black-rot of Grape.—The characteristic black perithecia of the fungus *Loestadia Bidwilli* was seen on the leaves, but, as there was no fruit this year, not much damage was done. The standard fungicide was applied, and proved sufficient to hold the disease in check.

Black Rust of Grape.—This is a disease of grape foliage rather common on sandy soils where the vines are trained low and the tips trail upon the ground. The leaves turn brown from the tip, following the mid rib. Afterwards the brown spot becomes covered with a black powder—the so-called rust. This disease was apparent on many of our grape plots, more especially in the Delaware rows. The death of many of the Delaware vines was directly due to this disease. The browning of the leaves is due to abstraction of the sap by the hot sand upon which the leaves lie or touch as they sway in the wind. The subsequent blackening of the leaves is caused by a fungus, *Macrosporium commune*. The only practicable remedy was to prevent the leaves from touching the soil by tying up the young canes.

Leaf Spot of Black-, and Raspberries.—Both the blackberry and raspberry plants suffered considerably from leaf spot, caused by the fungus *Septoria rubi*. The standard fungicidal spray was effective against these.

BULLETIN No. 160. JANUARY 18, 1899.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

W. A. WITHERS, A. M., ACTING DIRECTOR.

DIGESTION EXPERIMENTS.

F. E. EMERY.

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M..........Professor of Chemistry.
F. E. EMERY, M. S..........Professor of Agriculture.
W. F. MASSEY, C. E..........Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D..........Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.

F. E. EMERY, M. S..........Agriculturist.
W. F. MASSEY, C. E..........Horticulturist.
COOPER CURTICE, D. V. S., M. D..........Veterinarian.
G. S. FRAPS, B. S..........Assistant Chemist.
J. A. BIZZELL, B. S..........Assistant Chemist.
H. W. PRIMROSE, B. S..........Assistant Chemist.
ALEX. RHODES..........Assistant Horticulturist.
C. W. HYAMS..........Assistant Botanist.
J. M. JOHNSON, M. S..........Assistant Agriculturist.
B. S. SKINNER..........Farm Superintendent.
J. M. FIX..........Secretary.
C. M. HUGHES, B. E..........Clerk.
MRS. L. V. DARBY..........Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A. M..........State Chemist.
C. B. WILLIAMS, M. S..........Assistant Chemist.
C. D. HARRIS, B. S..........Assistant Chemist.
F. G. KELLY..........Assistant Chemist.
W. G. HAYWOOD, B. LITT..........Assistant Chemist.
H. E. KING..........Chief Clerk.
MISS M. S. BIRDSONG..........Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

DIGESTION EXPERIMENTS.

F. E. EMERY. AGRICULTURIST.

CRAB GRASS HAY ALONE, AND IN COMBINATION WITH COWPEA MEAL, CORN BRAN, AND RICE BRAN; FIRST AND SECOND GROWTHS OF GREEN RAPE.

[For previously reported workin this line from this Station, see Bulletins No. 80, 87, 97, 118, and 148.]

INTRODUCTION.

Crab grass hay is distinctively a Southern forage plant. It is an annual, growing vigorously in the wet period of midsummer, and seeding abundantly. Even when cut for hay it is believed usually to have reached such a stage of maturity that the next year's growth is assured from seed dropped. The ripening, as also the haying, is accompanied by such perfect weather that the straw is bright and fresh looking and even when seed has ripened, and the hay has past its best estate for digestion, its looks indicate an earlier stage of development than has actually been attained. Thus the crab grass hay, the digestion of which was reported in Bulletin No. 148, was about on a par with cotton-seed hulls In these trials crab grass hay has been used to feed with some by-products which are produced in the South and in North Carolina. The feeding value of these articles is considerable—we have sought to determine how great, and to establish a basis for comparisons between these and other by-products which are better known. Cowpea meal, one of the articles subjected to digestion for this bulletin, is not a by-product. It is the cowpea ground for feeding, and represents the full composition of the cowpea. The price is usually high for feed but can be cheapened by use of machinery in harvesting.

Peanut Meal, a by-product designed for cattle food was tried, but sheep would not eat enough of it even when they were fed nothing else to keep them from starving. Whether the fault lies with the sheep or this sample was old and the composition changed we do not know. It is hoped an opportunity to make another trial of this food may be found.

Corn and Rice Bran. These were the ordinary by-products of the corn and rice mills.

Green Rape. The growth and feeding of this plant is a new departure in the South, as indeed it is in most parts of this country. It was but just beginning to be grown generally in the Northwest,

following the lead of Prof. Thomas Shaw, of the Minnessota Experiment Station, when a fine crop was produced at Occoneechee Farm, Hillsboro, N. C., and it began to be cultivated at this Station. Seed and directions for growing the crop can be found with leading seedsmen.

The rape digested in these experiments was grown from late fall sowing and some of it from transplanted plants set in rows and cultivated. With us the most satisfactory crops come from drilled rows set close for one or two cultivations, and the plants when spreading out cover the whole ground, then feed off on the ground. This may be done with cattle or swine, but here sheep have been used exclusively, except that this Spring (1898) calves have been turned out with the sheep.

Success in growing rape may be attained by following the directions given for growing cabbage in Bulletin No 132, though less care and attention is bestowed on this forage plant, which must be grown cheaply and on a larger scale. It will pay, however, to sow in drills, thin the plants, and cultivate while it is small. In the North this crop is sown broadcast after grain harvest for fall grazing. In our dry, hotter climate two or three careful cultivations of drills will give better and more abundant food than to allow the plants to struggle with heat and weeds in broadcast seeding, unless the sowing is done in connection with cowpea vines for a partial shade during the early life of the rape.

As in Bulletin No. 148, table 1 contains all the analyses for the experiments reported here.

The feeding for these experiments was mostly done by R. D. Patterson, Jr., B. S., assisted at times by R. E. L. Crenshaw and F. E. Emery. The analytical work has been done by H. K. Miller, M. S., and G. S. Fraps, B. S., the calculations and writing up by F. E. Emery.

The sheep used in these experiments were the same as were used in the experiments reported in Bulletin No. 148. They were fed in the same stalls, in the same way, and in periods of about the same length. Good health and ready appetites were prominent characteristics during these experiments, except that, although hungry and in good health, the sheep refused the peanut meal persistently, and refused to subsist on corn bran fed alone, though they ate this bran readily when fed with hay.

(1) Digestion of Crab Grass Hay by Sheep, Nos. 3 and 4.

Date of experiment March and April, 1897. Crab grass hay fed 32 ounces daily to each sheep. Total period 25 days. Collections were made during the last ten days. The weights of the two sheep were maintained. Sheep No. 1 was turned out because it had reached other food and was uneasy in confinement. Sheep No. 2 made a

slight gain, loose, in box stall. All analyses are given in table 1. The coefficients of digestibility are as worked out in Table No. 2 as follows: For dry matter 54.9 per cent; for Ash 51.8 per cent; for Protein 32.0 per cent; for Albuminoids 28.8 per cent; for fat 35.6 per cent; for nitrogen, free extract, 52.8 per cent; crude fiber 64.4 per cent. Nutritive Ratio 1 : 19.5.

(2) Digestion of Crab Grass Hay and Cowpea Meal by Sheep, Nos. 3 and 4.

Date of experiment April and May, 1897. Crab grass hay fed, 16 ounces per day to each sheep. Cow-pea meal fed, 16 ounces per day to each sheep. Total period, 20 days. Collections were made the last ten days. The weights of the sheep were maintained and from the less amounts of food taken while the last weights were being obtained, there appears to have been a loss on two of them.

	Sheep No. 2.	Sheep No. 3.	Sheep No. 4.
Weights of sheep at close of 1st period	74.8	63.2	74.
Weights at the end of the 2nd period	69.8	66.7	71.3

All analyses are given in Table No. I. Coefficient of digestibility as worked out in Table No. III, and are as follows:

	Dry Matter. Per Ct.	Ash. Per Ct.	Protein (N×6.25). Per Ct.	Fat (Ether Extract. Per Ct.	N Free Extract. Per Ct.	Crude Fiber. Per Ct.
For the ration	70.9	45.9	70.5	54.7	76.5	64.3
For the pea meal	86.6	33.5	82.0	73.9	93.1	64.0

Nutritive ratio of ration of crab grass hay, 1 to 1.03; cowpea meal, based on dry matter, 1: 4.65.

Nutritive ratio of cowpea meal, 1: 3.2.

(3) Attempt to Feed Peanut Meal, a Coarsely Ground By-Product, Failed.

(4) Digestion of Crab Grass Hay and Corn Bran.

Date of experiment May and June, 1897. Crab grass hay 12 ounces, corn bran 28 ounces, per day. Total period 20 days. Collections were made the last ten days.

	Sheep No. 1.	Sheep No. 2.	Sheep No. 3.	Sheep No. 4.
Weight of sheep at beginning of this period	69.7	67.	54.	64.5
Weight of sheep at middle of period	79.	73.	62.7	69.7
Weight of sheep at beginning of 5th period	81.7	74.8	63.	69.

The weights are taken during all the time the sheep are not harnessed. Hence the three weights, taken at the beginning

of each preliminary period, serve to indicate whether there has been loss or gain during the previous experiment.

The short period after experiment 2, occupied by the failure (3), and two days when sheep were unsuccessfully tried on corn bran alone were so many days with very little food. During this time the weights fell off, and the three weights at the beginning of period (4) were low. The weights in the middle of the period an average of the three last, before harnesses were put on for collections, show that the normal weights had been recovered and that the sheep in harness fairly held their weights during the collection period, while sheep Nos. 1 and 2 continued to gain some in weight. All analyses are given in Table I, while the coefficients of digestibility, as worked out in Table IV, and are as follows:

	Dry Matter. Per Ct.	Ash. Per Ct.	Protein (N×6.25) Per Ct.	Fat (Ether Extract.) Per Ct.	N Free Extract. Per Ct.	Crude Fiber. Per Ct.
For the ration.....	66.1	16.5	48.7	69.1	74.5	59.7
For corn bran...	70.5	.....	53.4	72.3	79.6	53.1

Nutritive ratio for corn bran, 1: 14.

Nutritive ratio of ration of crab grass hay 1 to corn bran 2⅓, on dry matter basis is 1: 14.57.

(5) (6) Digestion of Green Dwarf Essex Rape by Sheep Nos. 3 and 4, and Nos. 1 and 2.

Date of experiment June, 1897.

Green rape fed 9 pounds daily to each sheep in three even feeds. Rape plucked fresh for every feed in imitation of grazing.

The first day only 6 pounds were thus fed. Total period, 20 days. Collections were made the last ten days of the period with each pair of sheep.

	Sheep No. 1.	Sheep No. 2.	Sheep No. 3.	Sheep No. 4.
Weight of sheep, average 1st, 2nd and 3rd days.....	81.7	74.8	63.0	69.0
Weight of sheep, average 8th, 9th and 10th days....	74.	71.2	59.5	64.8
Weight of sheep, average at beginning of 6th period,	77.3	76.3		

During the progress of this feeding it seemed as though the animals would have consumed more if it had been offered, but the 9 pounds had been expected to cloy the appetites of the smaller eaters before the period was out. Sheep Nos. 1 and 2 were fed through a second period on rape, in which these heartiest sheep were fed 5 pounds each of rape at a feed three times per day. Some waste resulted from this feed, enough to indicate *this* as truly ad-libitum feeding, if the 3 pounds per feed *had not been* for the other sheep. Sheep Nos. 3 and 4 were not fed through this part of the period and no records were taken of their weights when harnesses were removed. Thus the last weights were lost, and the mid period weights indicate losses in weight for all the sheep. Prac-

tically no water was drunk when sheep were fed on green rape, though the sheep took water from three to eight times each in the twenty days, mostly during the first week. Samples of rape were taken every day for analysis the same as it was cut for sheep, taking the entire product of one plant to be analyzed. The rape was increased to sheep Nos. 1 and 2, while the collections were being made with Nos. 3 and 4. The total time for sheep Nos. 1 and 2 was 36 days. Collections were made the last ten days.

These analyses will be found in Table I. The coefficients of digestibility, as worked out in Table V, are as follows:

	Dry Matter. Per cent.	Ash. Per cent.	Protein (N×6.25) Per cent.	Albuminoids Alb N×6.2.	Fat (Ether Extract.) Per cent.	N Free Extract. Per cent.	Crude Fiber. Per cent.
For sheep 3 and 4	88.5	76.5	90.2	86.6	54.2	93.8	90.
For sheep 1 and 2	81.0	48.9	87.4	86.1	42.8	89.9	84.
Mean of 4 sheep	84.8	62.7	88.8	86.4	48.5	92.0	87.

Digestion of Crab Grass Hay and Rice Bran.

Date of experiment July, 1897. Each of the four sheep received 12 ounces of hay and 12 ounces of rice bran per day in three equal feeds. Total period 20 days. Collections were made during the last 10 days.

	Sheep No. 1.	Sheep No. 2.	Sheep No. 3.	Sheep No. 4.
Average weights of sheep at beginning	75.5	69.0	63.0	68.3
Average weights of sheep before two collections	83.	77.5	65.3	69.0
Weight of each sheep at end of experiment	81.	78.*	67.8	71.0

* Only one weight and not an average of three weights as, usual.

The weights of sheep would seem to indicate that the sheep were all gaining during this period.

The analyses are collected in Table 1. The coefficients of digestibility, as calculated from Table 6, are as follows:

	Dry Matter per cent.	Ash per cent.	Protein (4 x 6.25) per cent.	Fat ether ex. per cent.	N—Free Extract per cent.	Crude Fiber per cent.
For the Ration	59.7	26.3	52.4	82.3	66.0	56.0
For Rice Bran	64.7	2.4	62.9	88.6	78.2	29.2

Nutritive ratio of ration when dry matter was consumed in the proportion of 1 hay to 1.05 of rice bran, 1: 10.13.

Nutritive ratio of rice bran, 1:7.48.

TABLE I.—Showing Percentage Composition of Foods, Waste, and Solid Excrement.

Farm Number.	No. of Analysis.		Water.	Dry Matter.	Dry matter contains: Ash.	Protein (N × 6 25.)	Albuminoids (Alb. N × 6.25.	Fat. (Ether Extract.)	Nitrogen Free Extract.	Crude Fiber.
755	754	Crab grass hay.	9.86	90 14	8.01	7.73	7.66	1.86	46.15	36.25
756	753	Crab grass hay, Sheep No. 3	10 76	79.24	8 21	7.70	7.22	1.75	45.19	37.15
793	814	Waste crab grass hay.	9.16	90.84	7.69	8.39	8.26	2 10	47.01	34.81
795	816	Waste crab grass hay, Sheep No. 4	9.25	90.75	7.61	8 16	7.85	2.15	48.17	33 91
	762	Solid excrement, Sheep No. 3	74.77	25.23	10.60	16 28	16 28	2.96	44.98	25.18
	763	Solid excrement, Sheep No. 4	83.01	16.99	11 37	17 29	17.29	2.77	44.34	24 23
771	761	Waste crab grass hay and cowpea meal, Sheep No 4	9.52	90.43	10.33	12.98	11.26	2.34	38.94	35.42
	819	Green rape, Je. 20–30 '97	81.52	18 48	13.07	23.04	16.22	4.42	46.41	13.06
	824	Waste rape, Sheep No. 3	88 25	11.75	16.02	10.15	6.74	1.36	54.72	17.75
	823	Waste rape, Sheep No. 4.	85.78	14.22	34 77	18.21	10.64	2.29	31.28	13.45
	913	Solid excrement, Sheep No. 3	61.40	38.60	27.60	18.26	17.75	17.34	25.48	11.72
	912	Solid excrement, Sheep No. 4	75.44	24.56	25.33	21.22	20.08	18 00	24 44	11 01
	820	Green rape, July	85 46	14.54	14.68	27.93	21.87	4 25	42.49	10 55
	822	Waste green rape, Sheep No. 1	81.44	18.56	33.51	23.14	16 73	3.32	28.65	11.38
	821	Waste green rape, Sheep No. 2	86.30	13.70	22.19	26.32	16 48	3.80	33.51	14.18
	910	Solid excrement, Sheep No. 1	70.87	29.13	38 02	17.17	16.40	13.57	21.89	9.35
	911	Solid excrement, Sheep No. 2	74.42	25.58	39.12	16.48	15.84	12.21	23 81	8.38
759	759	Cowpea meal	12 63	87.37	3 86	25.47	24.68	1.82	64 63	4.22
899	918	Waste rice bran, Sheep No. 1	8.13	91.87	9.20	14.80	14.56	10 80	51.66	11.54
746	755	Waste crab grass hay, Sheep No. 3	9.73	90 27	7.78	7.07	6.93	1 58	36.77	46 80
	757	Solid excrement, Sheep No. 3	63.98	36.02	8 96	12.38	11.75	2.83	49.83	26.00
	915	Solid excrement, Sheep No. 2	73.55	26.45	15.58	12 25	11.95	2.51	41.15	28.51
	914	Solid excrement, Sheep No. 1	72.23	27.77	16.02	14 16	13.95	3.36	40.39	26.07
	818	Solid excrement, Sheep No. 4	76.20	23.80	9.76	14.78	14.78	4.37	49.45	21.64
	815	Solid excrement, Sheep No. 3	74.98	25.02	9.98	14.48	14.23	4.92	49.24	21.38
748	756	Waste crab grass hay, Sheep No. 4	12.03	87.97	7.75	8.73	7.82	2.12	45.44	35.96

TABLE I.—CONTINUED.

Farm Number.	No. of Analysis.		Water.	Dry Matter.	DRY MATTER CONTAINS					
					Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fat. (Ether Extract.)	Nitrogen Free Extract.	Crude Fibre.
	758	Solid excrement, Sheep No. 4....	74.16	25 84	8.88	11.15	11.15	2.24	49 28	28 45
	760	Waste hay and meal, Sheep No 3	11 82	88.18	8 10	8 28	7 65	1.79	47 18	34.65
	812	Corn bran..............	10.80	89.20	2.66	10.95	10.90	6 48	69.46	10.45
794	813	Waste corn bran, Sheep No. 3 ..	10.42	89.58	4.42	13.43	13.40	7.16	64.52	10.47
796	817	Waste corn ran, Sheep No. 4...	10.01	89.99	4 36	13.02	12 65	6 05	64.72	11.85
	917	Rice bran	10.22	89.78	9.17	15.04	14 90	11.94	51 75	12 10
	919	Waste crab grass hay, Sheep No. 1	8.29	91.71	9.02	10.84	6 68	4.49	45.09	30.56

TABLE II.—SHOWING NUTRIENTS CONSUMED AND EXCRETED IN GRAMS WITH PERCENTAGE DIGESTED.
(First Experiment, March and April, 1897, Crab grass hay alone).

SHEEP NO. 3.

No. of Analysis.		Total Amount. *Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams. Ash.	Protein (N × 6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
753	Crab grass hay fed in 10 days	9072.	8095.9	664.7	623.4	584.5	141.7	3658.5	3007 6
755	Waste crab grass hay in 10 days	3195 5	2845.8	221.4	201.2	197.2	45 0	1046.4	1331.8
	Total consumed		5250.1	443 3	422.2	387.3	96 7	2612 1	1675.8
757	Total solid excrement in 10 days	6660 2	2399.0	215.0	297.0	281.9	67.9	1195.4	623.7
	Total digested		2851.1	228.3	125 2	105.4	28 8	1416.7	1052.1
	Per cent. digested		**54 31**	**51.50**	**29 65**	**27.21**	**29 78**	**54.24**	**62.78**
	SHEEP NO. 4.								
753	Crab grass hay fed in 10 days	9072.0	8095.9	664.7	623.4	584.5	141 7	3658.5	3007.6
756	Waste crabgrass hay in 10 days	1005.1	881.2	68.5	77.2	69.1	18.7	401.8	318.0
	Total consumed		7214 7	596.2	546 2	515.4	123 0	3256.7	2689.6
758	Total solid excrement in 10 days	12439.3	3214.3	285.4	358.4	358.4	72.0	1584.0	914.5
	Total digested		4000.4	310.8	187.8	157 0	51.0	1672.7	1775.1
	Per cent. digested		**55.45**	**52.13**	**34.38**	**30.46**	**41.46**	**51 36**	**66 00**
	Mean per cent. digested by both animals		**54.9**	**51.8**	**32 0**	**28.8**	**35 6**	**52 8**	**64 4**

Mean nutritive ratio, 1:19.5.

* 28.35 grams are equal to 1 ounce. 453.6 grams are equal to 1 pound.

TABLE III.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.
(Second Experiment Digestion Crab grass hay and Cowpea meal fed 1 to 1).

Sheep No. 3.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams. Ash.	Protein (N × 6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
754	Crab grass hay fed in 10 days	4536.0	4088.8	327.5	316.1	313.2	76.1	1887.0	1482.2
759	Cowpea meal fed in 10 days	4536	3963.1	153 0	1009.4	978.1	72 1	2561.4	167.2
	Total fed in 10 days	9072.	8051 9	480.5	1325.5	1291.3	148.2	4448.4	1649.4
760	Waste hay in 10 days, 3	350.5	317.0	25.7	26 2	24.3	5.7	149.6	109.8
	Total consumed	....	7734.9	454.8	1299.3	1267.0	142.5	4298.8	1539.6
762	Total solid excrement in 10 days, 4	8605.1	2170.9	230.1	353.4	353 4	64.3	976.5	546.6
	Total digested	....	5564.0	224.7	945.9	913.6	78.2	3322.3	993.0
	Digested from crab grass hay, first experiment	....	2070.7	156.3	92.8	90.2	25.1	917.3	883.4
	Digested from cowpea meal	....	3493.3	68.4	853.1	823.4	53.1	2405 0	109.6
	Per cent. of ration digested	....	71 93	49.41	72.80	72.11	54.88	77.28	64.50
	Per cent. of cowpea meal digested	....	88 15	44.70	84.51	84.18	73.65	93.89	65.55

TABLE III—CONTINUED.

SHEEP NO. 4.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams. Ash.	Protein (N × 6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
754	Crab grass hay fed in 10 days	4536.	4088.8	327.5	316.1	313.2	76.1	1887.0	1482.2
759	Cowpea meal fed in 10 days	4536.	3963.1	153.0	1009.4	978.1	72.1	2561.4	167.2
	Total fed in 10 days	9072.	8051.9	480.5	1325.5	1291.3	148.2	4448.4	1649.4
761	Waste hay in 10 days	26.	23.5	2.4	3.1	2.6	.6	9.2	8 3
	Total consumed	....	8028.4	478.1	1322.4	1288.7	147.6	4439 2	1641.1
763	Total solid excrements in 10 days	14278.1	2425.2	275.7	419.3	419 3	67.2	1075 3	587.6
	Total digested	....	5603.2	202.4	903.1	869.4	80.4	3363.9	1053.5
	Digested from crab grass hay	....	2231.8	168.4	100.2	89.5	26.9	991.5	949.2
	Digested from cowpea meal	....	3371.4	34.0	802.9	779.9	53.5	2372.4	104.3
	Per cent. digested from ration	....	69 79	43.33	68.29	67 46	54 47	75.78	64.19
	Per cent. digested from cowpea meal	....	85 07	22.22	79.54	79.74	74.20	92.23	62.38
	Mean per cent. digested from ration	....	70.9	45 9	70.5	69 8	54 7	76.5	64 30
	Mean per cent. digested from cowpea meal	....	86.6	33 5	82.0	82.0	73.9	93.1	64.0

Mean nutritive ratio of ration of cowpea meal to crab grass hay consumed in proportion of 1 to 1.03 on dry matter 1: 4.94.
Mean nutritive ratio of cowpea meal 1: 3.2.

TABLE IV.—SHOWING NUTRIENTS CONSUMED AND EXCRETED IN GRAMS WITH PERCENTAGES DIGESTED.
(Fourth Experiment, Digestion of Crab grass Hay and Corn Bran.)

SHEEP NO. 3.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams. Ash.	Protein N × 6.25.	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N Free Extract.	Crude Fiber.
753	Crab grass hay fed in 10 days........	3402.	3035.6	249.2	233.8	219.2	53.1	1371.9	1127.8
812	Corn bran fed in 10 days............	7938.	7080.7	188.3	775.3	771.8	458 8	4918.3	739.9
	Total fed in 10 days	..	10116.6	437.5	1009.1	991.0	511.9	6290 2	1867.7
813	Waste bran	1257.9	1126 8	49.8	151.3	151.0	80.7	727.0	118.0
814	Waste hay	340.9	309.7	23.8	26.0	25.6	6.5	145.6	107.8
	Consumed in crab grass hay	....	2726.2	225.4	207.8	193.6	46.6	1226.3	1020.0
	Consumed in corn bran..............	....	5953.9	138.5	624.0	620.8	378.1	4191.3	621.9
	Total consumed	....	8680.1	363.9	831.8	814.4	424.7	5417.6	1641.9
815	Total solid Excrement..............	11875.8	2971.8	296.6	430.3	422 9	146.2	1463.3	635.4
	Total digested in 10 days	....	5708 3	67.3	401.5	391.5	278.5	3954.3	1006.5
	Digested from crab grass hay.........	....	1496.7	116.8	66.5	55.8	16.6	647.5	656.9
	Digested from corn bran............	....	4211.6	....	335.0	335.7	261.9	3306.8	349.6
	Per cent digested from ration	....	65.75	18.49	48 27	48 07	65 58	72 99	61 30
	Per cent digested from corn bran......	....	70.77	....	53.69	54.08	69.27	78.90	56.21

TABLE IV—CONTINUED.
SHEEP NO. 4.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams: Ash.	Protein N × 6.85.	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
753	Crab grass hay fed in 10 day	3402.	3035.9	249.2	233.8	219.2	53.1	1371.9	1127.8
812	Corn bran fed in 10 days	7938.	7080.7	188.3	775.3	771.8	458.8	4918.3	739 9
	Total fed in 10 days	....	10116.6	437.5	1009.1	991.0	511.9	6290.2	1867.7
817	Waste corn bran in 10 days	14744.	1326.8	57.8	172.7	167.8	80.3	458.7	157.2
816	Waste hay in 10 days	12766.	1158.5	88.2	94.5	90.9	24.9	558 0	392.8
	Total consumed in 10 days	....	7631.3	291.5	741 9	732.3	406.7	5273.5	1317.7
818	Total Solid Excrement in 10 days	10732.1	2554.1	249.3	377 5	377.5	111.6	1263.0	552.7
	Total digested	....	5077.2	42.2	364.4	354.8	295.1	4010.5	765.0
	Digested from crab grass hay	....	1030.7	83 4	44.6	37.0	10.0	429.7	473.3
	Digested from corn bran	....	4046.5	....	319.8	317.8	285.1	3580.8	291.7
	Per cent digested from ration	....	66.53	14.47	49.12	48.45	72.56	76.05	58.06
	Per cent digested from corn bran	....	70.33	....	53.07	52.62	75.32	80.29	50.06
	Mean per cent digested from ration	....	66.1	16.5	48.7	48.3	69.1	74.5	59.7
	Mean per cent digested from corn bran	....	70.5	....	53.4	53.7	72.3	79.6	53.1

Mean nutritive ratio of crab grass hay and corn bran consumed in proportion of 1:2.33 of dry matter, 1:14.57. Mean nutritive ratio of corn bran 1:14.

Sheep No. 1.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Dry Matter Contains in Grams. Ash.	Protein. (N×6.25).	Albuminoids. (Alb. N×5.25).	Fat (Ether Extract).	N Free Extract.	Crude Fiber.
829	Green rape fed in 10 days	68040.	9893.0	1452.3	2763.1	2163.6	420.5	4213.4	1043.7
822	Waste Green rape	1216.	225.6	75 6	52 20	37.7	7.5	64.6	25.7
	Total consumed		9667.4	1376.7	2241.1	2125 9	413.0	4148.8	1018.0
910	Total solid excrement in 10 days	6091.0	1774.3	674 6	304.6	291.0	240.8	388.4	165.9
	Total digested		7893.1	702.1	1936.5	1834.9	172.2	3760.4	852.1
	Per cent. digested		87.65	51.0	86.41	86.31	41.70	90 64	83.70

Sheep No. 2.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	Ash.	Protein. (N×6.25).	Albuminoids. (Alb. N×5.25).	Fat (Ether Extract).	N Free Extract.	Crude Fiber.
820	Green rape fed in 10 days	68040.	9893.0	1452.3	2763.1	2163.6	420.5	4213.4	1043.7
821	Waste rape	2690.	368.4	81.7	97.0	60.7	14.0	123.5	52.2
	Total consumed		9524.6	1370.6	2666.1	2102.9	406.5	4089.9	991.5
911	Total solid excrement in 10 days	7295.9	1866.3	730.1	307.6	295.6	227.9	444.4	156.4
	Total digested		7658.3	640.5	2358.5	1806.3	178.6	3645.5	835.1
	Per cent. digested		80 41	46.73	88.46	85.90	43.94	89.11	84.23
	Mean per cent. digested		81.0	48.9	87.4	86.1	42 8	89.9	84.0
	Mean per cent. digested by 4 animals		84.8	62.7	88.8	86.4	48.5	92 0	87.0

Mean nutritive ratio 2nd growth, 1:2.32. Mean nutritive ratio, 4 animals 1st and 2nd growth, 1:2.6.

TABLE V.—SHOWING NUTRIENTS CONSUMED AND EXCRETED IN GRAMS WITH PERCENTAGES DIGESTED.
(Fifth and Sixth Experiments, Digestion of Green Dwarf Essex Rape.)

SHEEP NO. 3.

No. of Analysis.		Total Amount. Grams.	Dry Mattter. Grams.	Dry Matter Contains in Grams. Ash.	Protein (N×6.25).	Albuminiods (Alb. N×6.25).	Fat (Ether Extract).	N Free Extract.	Crude Fiber.
819	Green rape fed in 10 days	40818.	7543.2	985.9	1738.0	1223.5	333 4	3500.8	985.1
824	Waste rape	102.5	12 05	1.9	1.2	0.8	0.2	6.6	2.1
	Total consumed		7531.15	984.0	1736.8	1222.7	333.2	3494.2	983 0
913	Total solid excrement in 10 days	2258.5	871.8	240.6	159.2	154.7	151.2	222.1	102.2
	Total digested		6659.	743.4	1577.6	182.0	182.0	3272.1	880.8
	Per cent. digested		**88 4**	**75 55**	**90.83**	**87 35**	**54 62**	**93.64**	**89 60**

SHEEP NO. 4.

No. of Analysis.		Total Amount. Grams.	Dry Mattter. Grams.	Ash.	Protein (N×6.25).	Albuminiods (Alb. N×6.25).	Fat (Ether Extract).	N Free Extract.	Crude Fiber.
819	Green rape fed in 10 days	40818.	7543.2	985.9	1738.0	1223.5	333.4	3500.8	985.1
823	Waste rape	549.8	78.20	27.2	14 2	8.3	1.8	24.5	10.5
	Total consumed		7465.0	958.7	1723.8	1215.2	331.6	3476.3	974.6
912	Total solid excrement in 10 days	3470.5	852.2	215.9	180.8	171 1	153.4	208.3	93.8
	Total digested		6612 8	742.8	1543.0	1044.1	178.2	3268.0	880.8
	Per cent. digested		**88.6**	**77 48**	**89.51**	**85.92**	**53.74**	**94.01**	**90.38**
	Mean per cent. digested		**88.5**	**76.5**	**90.2**	**86.6**	**54 2**	**93.8**	**90.0**

Mean nutritive ratio 1st growth 1:2.95.

TABLE VI.—SHOWING NUTRIENTS CONSUMED AND EXCRETED IN GRAMS WITH PERCENTAGES DIGESTED.
(Digestion of Crab grass Hay and Rice Bran.)

SHEEP NO. 1.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	DRY MATTER CONTAINS IN GRAMS. Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fat. (Ether Extract.)	Nitrogen Free Extract.	Crude Fiber.
753	Crab grass hay fed in 10 days	4538.	4049.7	332 5	311 8	292.4	70.9	1830.1	1504.5
917	Rice bran fed in ten days	4538.	4074 2	373.6	612.8	607.1	486.5	2108.4	493.0
	Total fed in ten days	9076.	8123 9	706.1	924.6	899.5	557.4	3938.5	1997.5
918	Waste rice bran	993.5	912.7	84 0	135.1	132.9	98.6	471.5	123.6
919	Waste hay	572.5	525.0	47.4	56.9	35 1	23.6	236.7	160.4
	Consumed in crab grass hay in 10 days		3524.7	285.1	254 9	257.3	47.3	1593.4	1344.1
	Consumed in rice bran in 10 days		3161.5	289.6	477.7	474.2	387.9	1636.9	369.4
	Total consumed in ten days		6686.2	574.7	732.6	731.5	435.2	3230.3	1713.5
914	Total Solid excrement in 10 days	9542.	2650.0	424.5	375.2	369.7	89.0	1070.3	690.9
	Total digested in 10 days		4036.2	150.2	357.4	361.8	346.2	2160.0	1022.6
	Digested from crab grass hay in 10 days		1935.1	147.7	81.6	74.1	16.8	841.3	865.6
	Digested from rice bran in 10 days		2101.1	2.5	275.8	287.7	329.4	1318.7	157.0
	Per cent. digested from ration		**60·37**	**26·14**	**48·79**	**49·46**	**79·55**	**66·87**	**59·68**
	Per cent. digested from rice bran		**66·46**	**00·86**	**57·73**	**60·67**	**84 92**	**80·56**	**42·50**

TABLE VI.—SHOWING NUTRIENTS CONSUMED AND EXCRETED IN GRAMS WITH PERCENTAGES DIGESTED.
(Digestion of Crab grass Hay and Rice Bran.)
SHEEP NO. 2.

No. of Analysis.		Total Amount. Grams.	Dry Matter. Grams.	DRY MATTER CONTAINS IN GRAMS. Ash.	Protein (N × 6.25.)	Albuminoids (Alb N × 6.25.)	Fat. (Ether Extract.)	Nitrogen Free Extract.	Crude Fiber.
753	Crab grass hay fed and consumed in 10 days	4538.	4049.7	332.5	311.8	292.4	70 9	1830 1	1504 5
917	Rice bran fed and consumed in 10 days	4538.	4074.2	373.6	612.8	607.1	486 5	2108.4	493.0
	Total fed and consumed in 10 days	9076.	8123.9	706.1	924 6	899.5	557 4	3938 5	1997.5
915	Total solid excrement	12600.	3332.9	519.3	408.3	398.3	83.7	1371.5	950.2
	Total digested		4791.0	186.8	516.3	501.2	473.7	2567.0	1047.3
	Digested from crab grass hay		2223.3	172.2	99.8	84 2	25.2	966 3	968.9
	Digested from rice bran		2567.7	14.6	416.5	417.0	448.5	1600.7	78.4
	Per cent. digested from ration		58.97	26.46	55 84	55.72	84.98	65.18	52.43
	Per cent. digested from rice bran		63.02	3 91	67.97	68.69	92.19	75.92	15 90
	Mean per cent. digested from ration*		59.7	26 3	52.4	52.6	82.3	66.0	56 0
	Mean per cent. digested from rice bran		64.7	2.4	62.9	64.7	88.6	78.2	29.2

Mean nutritive ratio of ration on basis of dry matter 1 of rice bran to 1.05 hay 1:10.13.
Mean nutritive ratio of rice bran 1:7.48.

SUMMARY OF COEFFICIENTS OF DIGESTIBILITY DETERMINED BY N. C. EXPERIMENT STATION.

	Number of Bulletin.	No. of separate determinations.	Animal used.	Dry matter.	Ash.	Protein.	Albuminoids.	Fats (Ether extract).	N-Free extract.	Crude Fiber.	Nutritive ratio 1:
Cotton-seed hulls,	87d	1	cow	35.9	27.1	24.6	.....	80.6	40 3	27.1	32.5
Cotton-seed hulls, (above included)	80c-87d	4*	cows, goats	39.8	19.9	67.5	67.5	85.1	36 9	43.1	106 6
Cotton-seed hulls and meal, 7 to 1	80c	1	cow	44.9	34.2	44.3	44.3	81.0	51.4	33.9	10.8
Cotton-seed hulls and meal, 6 to 1	87d	2	steers	46.4	25.4	45.8	45.1	82.1	49 7	40.2	9.71
Cotton-seed hulls and meal, 4 to 1	87d	2	steers	53.5	46.0	54.4	53.4	84.8	57.9	45.0	7.52
Cotton-seed hulls and meal, 3 to 1	97	1	steer	55.0	28.9	61.0	60.5	87.0	55 3	49.6	5 89
Cotton-seed hulls and meal, 2.8:1	97	1	steer	51.5	33.0	62.3	61.8	84.2	51.8	43.6	5.13
Cotton-seed hulls and meal, 2.4:1	97	1	steer	52.0	30.3	61.6	61.1	83 7	53.6	43.1	4 88
Cotton-seed hulls and meal, 2:1	97	2	steers	53.6	26.8	64.7	64.2	82 3	49.5	49.5	4.27
Cotton-seed hulls and meal, 1.99:1 and 1.81:1	118	2	steers	55.1	38.3	64.0	64.0	84.2	54.8	46.2	3.77
Cotton-seed hulls and meal, 1.5:1 and 1.54:1	118	2	steers	56.0	33.9	65.1	65.1	85.3	56 4	47.7	3 18
Cotton-seed meal with crimson clover hay	97	4	....	73.3	31.5	87 8	87.1	89.7	61.5	46.4	1 38
Cotton-seed meal with sorghum Bagasse	97	1	....	65.0	3.0	85.5	85.7	92.	55.1	.....	.....
Corn meal alone	97	1	goat	86.9	....	66.9	66.9	80.5	94.2	....	14 02
Corn meal in rations with crimson clover hay	97	2	goats	92.4	46.0	58.6	.....	97.7	100.0	18.2	......
Corn and cob meal with crimson clover hay	97	2	goats	78.6	.....	45.9	.....	83.5	89.4	43.6	......
Corn and cob meal alone	97	1	goat	78.7	.....	65.2	71.3	84.6	85 8	47.7	13 2
Corn silage alone	87d	1	cow	53.2	26.9	34.4	26.4	66 0	60.5	43.2	19 96
Corn silage and cotton-seed meal, 12:1	87d	2	goats	63 2	14.7	63.3	61.1	85.0	67.6	56.2	6.29
Corn silage and cotton-seed meal, 8:1	87d	2	steers	70.5	36.0	70.9	67.9	80.2	75 5	61.3	4.98
Corn silage and raw cotton-seed, 2.66:1	87d	2	cow, goat	60.0	34.9	58 6	55.4	85.4	55 4	59.9	9 12
Cotton-seed raw	87d	2	cow	66 1	43.3	67 9	63.6	87.1	49.6	75.5	7 13
Cotton-seed roasted	87d	2	steer, heifer	55.9	.....	47.0	44.2	71.7	51.4	65.9	9.19
Corn silage and cotton-seed roasted 2:1	87d	2	heifer, steer	55.6	5.9	43.2	40.3	71.2	57 1	53.0	11.77
Cat-tail millet	97	2	goat	62.3	68.4	62.6	41.5	46.1	59 1	66.5	6.15
Cowpea vine hay	87d	2	cow, goat	59.2	45.1	64.5	47.5	50.0	70.7	42.9	5.27
Crimson clover hay	87d	2	goat, sheep	62.2	53.6	69.1	60.2	48.8	71.5	48.7	3.76
Crimson clover hay (1 year old)	97	2	cow, goat	61.1	59.4	68.2	61 1	43.3	66 6	51.4	4 47
Crimson clover hay and cotton-seed meal, 6.4 to 1	97	1	cow	61.9	54 3	74.2	69.8	68.0	64 1	51.2	3.73
Crimson clover hay and cotton-seed meal, 3.09 to 1	97	1	goat	66.9	54.3	81.3	78.9	75.4	67.5	55.0	2.68
Crimson clover hay and cotton-seed meal, {3.53 to 1 / 3.5 to 1}	97	2	cows	63.4	54.1	74.8	71.6	71.2	66.4	49.3	2.81

*Including cow given above.

SUMMARY OF COEFFICIENTS OF DIGESTIBILITY—CONTINUED.

	Number of Bulletin.	No. of separate determinations.	Animal used.	Dry matter.	Ash.	Protein.	Albuminoids.	Fats (Ether extract).	N-Free extract.	Crude Fiber.	Nutritive ratio.
Crimson clover hay and corn meal, 1.83:1	97	1	goat	73.6	62.1	70.6	.....	72.4	83.8	50.9	6.64
Crimson clover hay and corn m-al, 2.36:1	97	1	goat	69.0	41.8	62.3	.....	68.2	81.3	47.2	6.77
Crimson clover hay and corn and cob meal, 1:1.35	97	1	goat	70.4	49.1	59.3	.....	66.9	80.3	56.8	10.04
Crimson clover hay and corn and cob meal, 1.8 to 1	97	1	goat	65.7	44.7	63.7	.....	62.2	76.8	44.1	6.58
Soy bean hay	97	2	cow, goat	62.4	23.7	71.1	54.2	29.2	68.8	60.8	3.55
Soy bean silage	87d	2	goats	59.0	56.7	75.8	66.1	71.9	52.0	54.8	4.22
Pulled fodder (corn leaves alone)	87d	2	sheep, goat	55.5	13.5	56.0	52.5	63.0	58.9	60.7	8.73
Johnson-grass hay	97	1	goat	54.5	56.1	44.7	39.6	39.5	54.4	57.8	14.22
Peanut-vine hay	97	2	goats	59.9	20.4	63.3	53.0	65.9	69.5	51.9	7.69
Sorghum bagasse	97	1	goat	60.6	13.4	13.7	2.6	46.4	64.8	63.8	120.8
Sorghum bagasse and cotton-seed meal, 1.86 to 1	97	1	goat	62.2	7.1	77.8	77.3	84.5	62.5	54.1	4.19
Sorghum fodder (leaves alone)	97	2	cow, goat	63.1	29.5	60.8	45.1	46.7	64.5	70.4	8.94
Crabgrass hay	160	2	sheep	54.9	51.8	32.0	28.8	35.6	52.8	64.4	19.5
Crabgrass hay	148	4	sheep	50.7	44.4	.....	.....	42.6	51.0	58.4	99.5
Timothy hay	148	2	sheep	51.2	23.0	33.5	.....	17.6	58.0	48.0	26.1
2. Timothy hay and cotton-seed meal* †16:1 ‡15.15:1	148	2	sheep	55.3	22.8	50.7	.....	50.1	62.1	48.9	12.4
3. Timothy hay and cotton-seed meal* †12:1	148	2	sheep	53.6	21.2	55.9	55.7	64.1	59.9	47.2	9.9
4. Timothy hay and cotton-seed meal* †8:1 ‡7.91:1	148	2	sheep	48.9	10.4	54.9	58.4	61.5	55.0	41.7	7.72
5. Timothy hay and cotton-seed meal* †4:1 ‡3.95:1	148	2	sheep	51.5	.....	60.6	63.1	74.7	57.3	42.7	5.3
6. Timothy hay and cotton-seed meal* †2:1	148	2	sheep	59.1	14.7	71.4	73.9	84.9	66.9	39.5	3.5
7. Timothy hay and cotton-seed meal* †1:1	148	2	sheep	61.4	27.4	75.6	79.2	89.0	68.8	27.8	2.34
Timothy hay, second lot	148	2	sheep	54.2	28.7	35.1	36.0	49.2	66.1	42.2	25.3
Crabgrass hay and pea meal ‡1:1.03	160	2	sheep	70.9	45.9	70.5	69.8	54.7	76.5	64.3	.....
Pea meal	....	2	....	86.6	33.5	82.0	82.0	73.9	93.1	64.0	.....
Crabgrass hay and corn bran ‡1:2.33	160	2	sheep	66.1	16.5	48.7	48.3	69.1	74.5	59.7	14.57
Corn bran	....	2	....	70.5	.....	53.4	53.7	72.3	79.6	53.1	14.0
Crabgrass hay and rice bran ‡1:1.05	....	2	sheep	59.7	26.3	52.4	52.6	82.3	66.0	56.0	10.13
Rice bran	....	2	....	64.7	2.4	62.9	64.7	88.6	78.2	29.2	7.48
Green rape, first cutting	....	2	sheep	88.5	76.5	90.2	86.6	54.2	93.8	90.0	2.95
Green rape, second cutting	....	2	sheep	81.0	48.9	87.4	86.1	42.8	89.9	84.0	2.32
Green rape, mean of above	....	....	....	84.8	62.7	88.8	86.4	48.5	92.0	87.0	.....

*Digestibility of Timothy hay was calculated for each experiment. †Fed. ‡Consumed on basis of dry matter.

BULLETIN NO. 161 JANUARY 31, 1899

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION.

W. A. WITHERS, A. M., ACTING DIRECTOR.

DRINKING WATER.

CITY, TOWN AND RURAL SUPPLIES.

A. W. BLAIR.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.
W. A. WITHERS, A. M.....................................Professor of Chemistry.
F. E. EMERY, M. S.............. . ...Professor of Agriculture.
W. F. MASSEY, C. E............... .... Professor of Horticulture.
COOPER CURTICE, D. V. S., M. D......................Professor of Veterinary Science.

EXPERIMENT STATION STAFF.

W. A. WITHERS, A. M., Acting Director and Chemist.
F. E. EMERY, M. S............................ ....Agriculturist.
W. F. MASSEY, C. E...Horticulturist.
COOPER CURTICE, D. V. S., M. D ....Veterinarian.
G. S. FRAPS, B. S...Assistant Chemist.
J. A. BIZZELL, B. S...Assistant Chemist.
H. W. PRIMROSE, B. S............. .. ..Assistant Chemist.
ALEX. RHODES ....Assistant Horticulturist.
C. W. HYAMS..Assistant Botanist.
J. M. JOHNSON, M. S...Assistant Agriculturist.
B. S. SKINNER..Farm Superintendent.
J. M. FIX...Secretary.
C. M. HUGHES, B. E..Clerk.
MRS. L. V. DARBY..Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A. M ....State Chemist.
C. B. WILLIAMS, M. S..Assistant Chemist.
C. D. HARRIS, B. S............................... ....Assistant Chemist.
F. G. KELLY..Assistant Chemist.
W. G. HAYWOOD, B. LITT...................... ....Assistant Chemist.
H. E. KING..Chief Clerk.
MISS M. S. BIRDSONG...Stenographer.

The Director's office is in the main building of the College. Telephone No 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

DRINKING WATER.

City, Town and Rural Supplies.

A. W. BLAIR, A. M., State Chemist.

Introduction.

As this Station is often called upon to analyze samples of drinking water for the public, the publication of a bulletin of a general or popular nature giving some facts concerning the purity of water, the proper construction and care of wells, methods of collecting and sending samples, interpretation of results, and the effect of impure water on health, does not seem out of place.

The importance of having a pure wholesome drinking water, cannot well be over-estimated, and yet gross carelessness in this matter exists almost everywhere.

There may be a difference of opinion as to the construction to be put upon the terms pure and wholesome, but we are certainly not requiring too much when we ask that the water be almost entirely free from organic matter, both vegetable and animal; that it contain only a small amount of mineral matter in solution; be free from any odor (unless indeed it is a sulphur water) and free from any unnatural color. These requirements may indeed be met and still the water be impure, as when water, which to the unaided eye has every appearance of being pure, is fouled by typhoid fever germs. These germs, however, do not thrive so rapidly when there is little or no organic matter present and on this account much reliance may be placed in the test for organic matter. Dr. Frankland defines the essential qualities of a good drinking water to be "first, coolness and æration; secondly, freedom from organic matter of all kinds; thirdly, that it should never have been contaminated with sewage or manure in anv form, and finally, that it should be soft water, not over 5° of hardness."

Purity of Water.

Water, when judged by the chemical standard, does not occur pure in nature; even rain water caught in mountainous districts, far from the smoke of cities and the abodes of men, contains traces of impurities taken up from the air. When, however, the foreign substances are present in such small quantities as not appreciably to affect the physical properties and render it unfit for drinking purposes, it is popularly spoken of as pure.

Solvent Properties of Water.

Water has remarkable solvent properties and it is on this account that it becomes so readily contaminated. The number and variety of substances which it can take into solution greatly exceed that of any other fluid. Some substances as sugar and common salt dissolve with ease and considerable rapidity, while others, such as rocks of a granitic or sandstone nature, are almost entirely insoluble in water. Limestone, however, dissolves slowly in water which contains carbon dioxide in solution, and in this way certain waters become charged with limestone and other salts (sulphates and chlorides) to some extent, and are spoken of as "hard waters." The carbon dioxide is gathered by rain water, in small quantities from the atmosphere, but is obtained in much larger quantities from the soil, as it percolates through it where there is decomposing vegetable matter.

Waters which contain very small quantities of lime and magnesia salts are called "soft" since they lather freely with soap. Where these salts are present in considerable quantities a certain amount of soap is required to decompose them before a lather can be formed. If the hardness is caused by limestone it is called temporary, and can be remedied, to a great extent, by boiling the water. The boiling causes the carbon dioxide to be driven off and then the greater part of the calcium carbonate (limestone) settles to the bottom of the vessel. If the hardness is due to sulphates it is called permanent and the water is not rendered "soft" by boiling. Many gases are also readily dissolved or absorbed by water. Among these may be mentioned hydrochloric acid and ammonia, which are readily absorbed, and oxygen and nitrogen which are dissolved in much smaller quantities. This property of dissolving or absorbing gases is a very important one. It explains how waters may become contaminated by mere exposure to impure atmosphere, as when an uncovered cistern is so placed that impure gases may come in contact with the water.

The materials which are commonly found in natural waters may be classified as follows: Gasesous and Solids.

The gasesous materials are carbon dioxide, oxygen and nitrogen. The solids may again be classified as mineral and organic. The mineral matter consists chiefly of carbonate of lime and magnesia; sulphate of lime, magnesia and soda; chloride of sodium (common salt), and often a salt of iron. The organic material is the product of decomposed animal and vegetable matter. In addition to these many waters contain matter in suspension and this may be divided into organic, such as finely divided particles of dead vegetable matter and minute forms of vegetable and animal life, either living or dead; and inorganic substances such as fine soil, sand and clay.

Many mineral waters contain other chemical compounds not mentioned here, and some contain hydrogen sulphide in addition to the gases mentioned.

Sources of Drinking Water.

By far the greater portion of water which is used for drinking purposes, may be divided into the following classes according to the sources from which it is directly obtained:

Rain water.
Well Water { Driven. / Dug. / Artesian.
Spring water.
River water.

The impurities which are found in rain water are such as it has gathered from the air, in its passage to the earth, or from the roof upon which it fell. These impurities are: from the air, ammonia, carbon dioxide, and dust (ammonia and carbon dioxide are always present in the air in small quantities but do not in any way hurt the water for drinking purposes), and organic matter from the roof. If care be taken to keep the roof well cleaned off and the portions which are first caught after the rain begins, are thrown away, that which falls afterwards is very pure and makes excellent drinking water. Well water may be divided into two classes, that which comes from deep wells and that which comes from shallow wells. Of the two kinds the shallow well water is much more liable to be contaminated than that which comes from deep wells. Several reasons may be assigned for this. As a rule, shallow wells are not so thoroughly constructed as deep wells and consequently impurities enter more easily from the top, and in addition the surface water which makes its way into the well is apt to be charged with impurities gathered up from the surface near dwellings, barns and other buildings, and owing to the small amount of earth through which it has to filter these impurities are not oxidized and thus destroyed before they reach the water in the well.

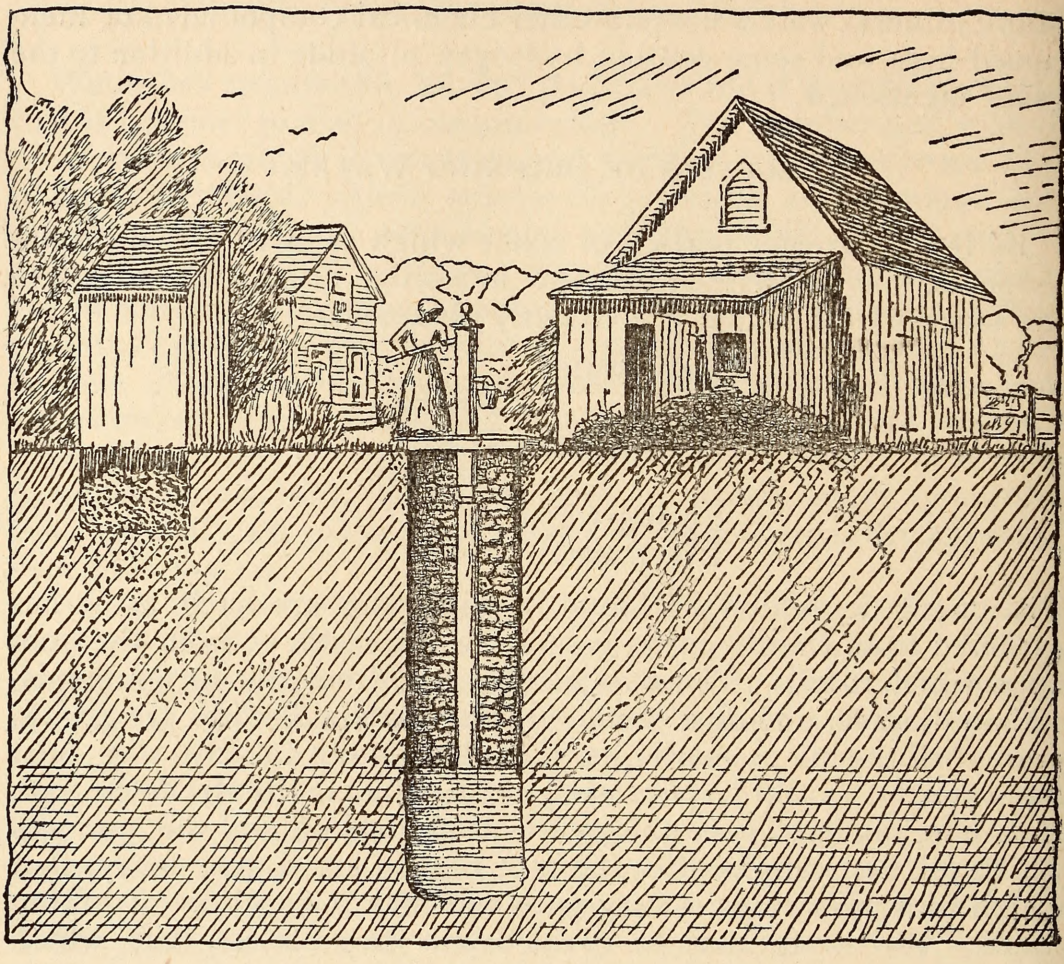


Fig. 1.—The shallow barnyard well, with privy vault and manure heaps near by. The water is likely to receive fluid from these at any time. (From Smith's Sewage Disposal on the Farm, Farmers' Bulletin No 43, U. S. Department of Agriculture.)

The water of deep wells on the other hand has to pass through thick layers of earth, sand and gravel and before it reaches the bottom of the well, the organic matter which it carried in suspension and solution has become oxidized and converted into harmless nitrates.

While in many instances the earth thus acts as an excellent filterer and purifier of water charged with filth, still it cannot always be depended upon to perform this office, since it is possible for it to become overcharged with filth, in which case it would cease to purify the water which percolated through it. As it is beyond the power of any one (at least without a chemical or biological examination) to tell just when the earth is acting as a filter, and when it ceases to do this work on account of over-saturation with filth, the only safe way is to see that no surface water is allowed to enter the well and also not to allow anything which may prove to be a source of contamination to the water, to accumulate on the surface within a radius of 75 to 100 feet of the well.

Organic matter of any kind is objectionable in potable waters.

while that derived from sewage or material of like character is highly dangerous, since it is in such waters that disease germs are most likely to exist, and multiply most rapidly. Hence it is that every possible precaution should be taken to prevent such material from entering the well The mineral matter which is held in solution may also prove to be a source of impurity in well water, though unless it is present in excessive amounts, this is, as a rule, harmless. The best waters rarely ever contain more than 15 to 20 grains per gallon of mineral matter, though this limit may be doubled and still the water be wholesome. Even perfect filtration by the earth would not always insure a pure water supply, for disease germs are sometimes carried by the water for a long distance under ground. Spring water, when the springs are properly cared for is usually of a high degree of purity, there being but little organic matter present in them, while the mineral matter when present in any considerable quantity, is often beneficial rather than injurious in character. Springs should be frequently cleaned out, and so constructed that surface water cannot run directly into them.

River water is used but little for drinking purposes except as it is used as the supply for large cities, and to treat this subject properly would require a special paper. It may be said in passing however, that as cities increase in population and as rural districts become more thickly inhabited, this question becomes more serious and the responsibilities of those in charge much greater. The excreta of one typhoid fever patient is sufficient, and has been known, to contaminate the water supply of a city.

The Construction and Care of Wells.

Although the shallow well is an institution of very early times, yet but few have been the improvements that have been made in its construction. In almost every other department of engineering, improvements have advanced with rapid strides but the shallow well, with (too often) the "moss covered bucket" seems to remain a heritage of the oldest civilizations. In some parts of this State wells can even now be found without anywall or lining, and many that are walled are scarcely better than those that are not, for they are so constructed that the surface drainage, which always contains more or less filth, (often more), can flow directly into them and thus contaminate any pure water which may have entered from the bottom. Others are left open at the top all the time, so that filth in the form of sticks, leaves, insects and even mice, rats and toads are not infrequently found, when the condition becomes so bad as to compel an examination. An instance has recently been brought to notice where a dead squirrel remained in a public well,

which was used by a great many people, about two weeks. Fortunately for those using the water, decomposition and putrefaction had not gone on to any great extent when the nuisance was detected. All such materials act as a source of contamination for the water; the leaves and the sticks being the least and the animal life, most harmful. Often parts of decayed curbing and covering are allowed to fall into the well, and these yield putrid organic matter to the water. Draw wells and dipping wells are also liable to be contaminated by the dirty vessels let down into them and especially is this true, where two buckets on one rope or chain are used, an arrangement which is often found at public wells, where the rope and bucket are handled by all classes.

In wells otherwise carefully constructed, filthy water is often allowed to run back into them through cracks in the pump platform, or along the track of the pipe leading from the pump to the well.

In a well properly constructed no water should be allowed to enter except that which comes from near the bottom, so that before reaching the well it must have passed through a considerable thickness of soil and thus have all the impurities which it may have originally contained, filtered out. This perfect filtration is not, however, always possible, as is instanced by the recent report made on the supply of potable waters of Camp Thomas at Chickamauga. From the report "it appears that nearly the whole camp is located above a magnesian limestone. The surface water passes directly through sink-holes and fissures into the small water pockets struck by the so-called artesian wells. Hence it has no chance of filtering and purifying itself, and after a freshet the wells give turbid water. There is obvious danger in drinking this water from a bacterian point of view and the report dwells upon the fact that this water, like that of most springs in limestone formation, being very "hard," not only fails to cook the food properly, but has an injurious effect upon nutrition." In the report, fault is found with the spring water, which after the other supply was abandoned, was hauled in barrels from different sources of supply. It appears that it was the custom to place an old canvas sack over the top of the barrel below the lid to prevent the spilling of the water. These sacks were often on the ground or on the floor of the wagon, and the impurities they picked up were washed out into the barrel by the splashing of the water against them. The report concludes by saying "that the terrible increase of sickness which has caused the camp to be abandoned has had the water supply for the main if not the exclusive cause. The July rains washed the microbe-laden atmosphere and the polluted soil, and carried the morbid material into the pockets of water struck by the pumps.

The spring water was polluted by the canvas bags and the muddy

bottoms of the pails. These causes account for the malarial and typhoid cases, while the loss of vitality, the lumbago, rheumatism, and stomach disorders are due, for the most part, to the hard water of the pumps and springs." This report only goes to confirm the fact which has already been well established, viz: that impure water is decidedly injurious to health, and that soldiers are no less likely to become victims of its use, than are ordinary men and women.

Several methods of preventing surface water from getting into wells have been suggested, but only brief reference can be made to the subject in this bulletin. Where the excavation is through solid rock, the walling with a cylinder of brick work or other material, will only be necessary to keep out the water from the more pervious surface soil. If it is desired, this wall may rest upon the top of the rock, but should be well lined inside with hydraulic cement and a joint should be made which is well nigh impervious to water. Where the excavation is all the way through clay or sand the work of lining is not quite so simple. For this work, however, terra cotta tubing has proved to be an excellent substitute for brick and rock. This tubing can be had in diameters from ten to twenty four inches and when properly put in with cemented joints forms a lining which is almost water proof and has proved entirely satisfactory in many cases. In no case should the cement be used below the water line. Whatever may be used for the lining, whether it be stone, brick, or terra cotta it should extend from one to three feet above the ground, according to the requirements, and be securely covered so that no foreign matter can enter the well.

Another method which has been suggested for overcoming the objection to shallow wells (since they must be looked upon as a sort of necessary evil) is to fill them up to the highest water level with gravel, and then over the gravel with sand to the top. Of course an iron pipe would have to traverse the sand and gravel and be connected with a pump at the surface. In this way any water which entered the pipe at the bottom if it came from the surface, must first have filtered through a thick bed of sand and gravel, and this would greatly improve the water by oxidizing and destroying the organic impurities. It is important, however, that the superficial layer of sand should be at least six feet in thickness, and if the subsoil water is reached at a depth less than ten feet it is probable that this method will not afford complete protection.

While much attention is now being given to the perfecting of systems of water works for large cities, it is still important that the supplies for small towns and rural districts be not neglected, and it is along this line that much can yet be done. By improving wells along some of the lines suggested above, the spread of typhoid

fever, in so far as it is due to water, may be restricted to a great extent. Wherever it is possible artesian wells are especially desirable since the water which comes from great depths in the earth is in most cases of high organic purity, and is not subject to contamination by impure surface water.

The Chemical Analysis.

The chemist is not able by purely chemical methods to detect disease germs as such in drinking water, but he is able to detect the presence of organic matter, and in an approximate way determine the amount of it, and as has already been stated, it is only when the organic matter is present that these disease germs can develop and multiply. If, therefore, any given water is very free from organic matter it is reasonable to suppose that there is little danger from specific disease germs.

Ammonia: By determining the amount of free and albuminoid ammonia, in a drinking water, the chemist can say whether there is much or little organic matter present and is also able in some instances to say whether it is of animal or vegetable origin, and this alone is an important step and furnishes valuable information when it comes to interpreting results. A water may contain a large amount of free ammonia and still be a good drinking water if there is little or no albuminoid ammonia present, but if there is a large quantity of albuminoid ammonia present the water must at least be considered suspicious, even if there is but little free ammonia. Chemists do not all agree as to the amount of ammonia which would be sufficient cause for condemning a water, but if free ammonia is almost entirely absent, it should not be condemned if the albuminoid ammonia does not exceed about .10 part per million. Albuminoid ammonia above .10 part per million is an indication that the water is of a suspicious nature and if it exceeds .15 part per million the water should be condemned, or at least immediate steps taken to correct the trouble.

Total Solids: The total solids are determined by evaporating a measured volume to dryness and weighing the residue. This gives the amount of matter that is held in solution and suspension by the water. The substances in solution may be of mineral or organic origin; the former derived from the rocks and soil with which the water has come in contact, and the latter from decomposing animals and plants, from manured soils, sewage, etc. No hard and fast line can be drawn indicating the amount of solids permissible in a drinking water, for that depends upon the character of the substances present. The purest drinking waters usually contain less than twenty (20) grains per gallon, but many excellent drinking waters contain double this amount.

Hardness: When, however, the total solids exceed about ten grains per gallon the usefulness of the water for domestic purposes may be greatly impaired on account of hardness. It is also claimed that vegetables cook more rapidly in soft than in hard water, and that for cooking meat and making soup, hard water is not so good as soft, as the former tends to compress the pores, while the latter tends to open them; also that soft water extracts the flavor of both vegetables and meat and the juice and gravy of the latter, much better than hard water. It is well understood that hard water is not suitable for boiler purposes. Waters under 5° or 6° of hardness may be considered "soft"; those exceeding 10° or 12° "hard."

Chlorine: The chlorine which is present in drinking water is usually due to the presence of sodium chloride (common salt) or other chlorides, which are in no way injurious; though it may be due to the presence of sewage, in which case it would be cause for condemning the water. The great danger in sewage polluted water is the possible presence of typhoid fever germs. Except where the total solids are high, a water which contains more than five (5) grains of chlorine per gallon should be regarded as suspicious. Recently a sample of water was analyzed in this laboratory which contained 56.42 grains of chlorine per gallon, and this amount under many circumstances, would have been sufficient cause for immediate condemnation, but when it was found that the total solid residue was 137.7 grains per gallon, and that this residue consisted largely of magnesium and calcium compounds it was not difficult to explain the presence of so much chlorine.

Nitrates and Nitrites: In some instances where the water is suspected as having been the cause of typhoid fever, tests are made for nitrates and nitrites.

Drinking Water in its Relation to Disease.

While it is not possible in a paper of this nature to fully discuss the relation between drinking water and disease, yet it may be stated that it is a well established fact that impure water is a fruitful cause of disease, and that in the majority of cases the disease is caused by the organic matter present. It is believed that matter which is in suspension is the most harmful, and especially when derived from recent sewage and fecal matter. Dr. A. H. Hassall, in his treatise on drinking water, states that the following diseases and disorders have all been produced by impure water, namely: dysentery, dyspepsia, diarrhœa, cholera, typhoid fever, scarlet fever, malarious fever and ague. Typhoid fever germs cannot exist for any length of time in pure cold spring water, because there is too little for them to feed upon, but polluted waters furnish the necessary conditions for their growth and multiplication, in the products of decomposing organic matter.

The Michigan State Board of Health, after a careful study of the subject, has established a very close relation between the depth of water in wells and sickness from typhoid fever. The maximum of sickness and minimum of water are coincident in the month of October. This is probably due to the fact that when the water is lowest its contaminations are most concentrated. The frequent outbreaks of typhoid fever which are directly and unmistakably traceable to drinking water contaminated with infected matter from typhoid fever patients point to this as the chief source of danger.

The following, taken from a document issued by the Michigan State Board of Health, should receive the thoughtful attention of every one:

"The most scrupulous care should be taken to keep the present sources of drinking water pure, and to procure future supplies only from clean sources. The general water supply of cities and villages is a matter of greatest concern; it should be procured from places where there can be no probability of immidiate or remote contamination. The well known outbreak of typhoid fever at Plymouth, Pa., where over a thousand cases and one hundred and fourteen (114) deaths occurred, is apparently an illustration of how great a calamity may follow the fouling of a general water supply by the discharges of a person sick with typhoid fever. When there is no general water supply, nor good sewers, much may be done to protect wells by the abolition of cess-pitts and privy vaults, by the use of dry earth in privies, and by the frequent removal therefrom of all their contents. * * * Privies often drain into wells, unsuspected by those who use the water. Should typhoid fever discharges pass into such a privy, an outbreak of typhoid fever among those using the water from a neighboring well would be likely to occur. If such a well were the source of the general water supply of a city, typhoid fever might soon be epidemic there. * * * There is good reason to suspect the water of a well whenever a vault is situated within a hundred feet of it, particularly if the soil be porous. In numerous instances fluids from excreta have leached into wells from much greater distances; and it has been proved that a well thirty rods from a cemetery received water which had filtered through the soil of the cemetery. Dangerously contaminated water may be, and often is found to be, clear and colorless, and to have no bad taste."

The noted instance at Lausanne, Switzerland, where the discharges from typhoid fever patients were thrown into a small stream, which disappeared by sinking into the earth and gravel and reappeared about a half a mile distant as a mountain spring, the clear water of which caused typhoid fever in one hundred and forty-four (144) persons, is instructive, and is worthy of note as illustrating how the disease may be spread. Filth and bad sani-

tary conditions of premises generally, increase the danger of spreading typhoid fever. Good water supplies, drainage and sewers, generally restrict typhoid fever, as well as other communicable diseases. One should not drink water which has a bad taste or odor, or which comes from a source that renders it likely to be impure.

The following table shows results of the analysis of a number of samples of water sent to the Station during the past year. All classes of water from very bad to exceedingly pure are represented.

A careful study of the table discloses the fact that the driven and artesian well waters are in most instances comparatively free from organic impurities, and that of the dug wells, those that are deepest furnish water of a higher degree of organic purity than the shallow wells.

CHEMICAL ANALYSES OF DRINKING WATERS.

Experiment Station Number.	Description of Water.	Grains per U. S. Gallon.			Parts per Million.		Remarks
		Total Solids.	Chlorine.	Hardness. Equivalence in Carbonate of Lime.	Free Ammonia.	Albuminoid Ammonia.	
10487	Spring	1.50	0.250	0.416	.0800	.1100	Organic contamination, suspicious.
10488	Pond	7.41	0.416	1.000	.4000	.5340	Very foul, exceedingly dangerous.
10500	City hydrant	5.91	0.416	2.330	.3600	.1877	Organic contamination, very bad.
10502	City supply	3.33	0.330	0.580	.0449	.2155	Organic contamination, very suspicious.
10506	City supply	5.08	1.250	0.780	.2400	.1935	Contaminated to a dangerous extent.
10507	City hall hydrant, city supply	4.08	0.766	0.910	.0233	.0435	Good safe water.
10512	Hydrant, city supply	3.67	0.275	0.750	.1730	.0505	Fair water.
10513	Public hydrant, city supply	3.25	0.250	0.420	.0670	.0203	Good safe water.
10517	Hydrant, city supply	4.58	0.300	0.920	.0310	.0787	Fair safe water.
10518	Pump at residence	4.33	0.400	1.200	.0270	.0237	Good pure water.
10519	Pump at residence	5.58	1.160	1.210	.0282	.0362	Good pure water.
10526	Well	5.83	0.330	2.225	.0682	.1240	Organic matter present, suspicious.
10531	Well No. 1, city supply	2.92	0.460	1.250	.0510	.0500	Pure water.
10532	Well No. 2, city supply	3.25	0.670	1.920	.0316	.0500	Pure water.
10533	Well No 3, city supply	3.17	0.250	1.080	.0500	.0487	Pure water.
10534	Well No. 4, city supply	1.17	0.208	0.670	.0440	.0312	Pure water.
10537	Pump	23.67	0.670	16.580	.0366	.7300	Exceedingly dangerous on account of organic contamination, very hard.
10542	Well	2.75	0.420	0.625	.0600	.3850	Highly contaminated, dangerous
10548	Pump, suspected	6.66	1.330	0.920	.7730	.0610	Very suspicious.
10553	Driven well	1.33	0.250	0.420	0082	.0175	Very pure water

10554	Driven well 2,500 feet from building.	2.66	0.250	0.540	.0100	.0237	Very pure water
10555	Well	21.33	3.000	10.830	.0100	.0412	Good safe water, but hard.
10556	Well	14.50	1.960	9.330	.0082	.0737	Safe pure water, but hard.
10557	Spring water	14.25	2.170	4.170	.0849	.4575	Dangerous water for drinking.
10568	Spring water	4.66	0.250	1.000	.0066	.1450	Slightly contaminated with organic matter, suspicious.
10581	Well water	5.08	1.000	0.830	.1060	.3162	Organic contamination to a dangerous extent.
10582	Artesian well, 765 feet deep	12.75	0.580	4.160	.0000	.0325	Very pure water.
10583	Driven well	5.00	0.166	1.500	.0033	.0075	Exceedingly pure water.
10597	City supply	2.16	0.160	0.330	.0130	.0325	Very pure water.
10598	City supply	9.58	0.790	2.160	.0073	.0175	Very pure water.
10601	City supply	4 83	0.250	1.750	.0049	.0899	Safe pure water.
10603	Camp supply	4.92	0.170	0.500	.0700	.3100	Contaminated to a dangerous extent.
10605	Public well about 50 feet deep, wooden wall.	4.33	0.350	1.170	.0961	.2162	Probably contaminated by vegetable matter, very suspicious.
10606	Public well about 50 feet deep, wooden wall.	4.00	0.330	0.920	.1000	.1700	Probably contaminated by vegetable matter, very suspicious.
10607	Reservoir on small stream	4.83	0.175	0.420	.0300	.2275	Probably contaminated by vegetable matter, very suspicious.
10608	Well	2.75	0.420	0 920	.0100	.1375	Contained green moss, very suspicious.
10610	Well	6.92	0 920	2.080	.0100	.0325	Good pure water.
10611	Surface well, 20 feet deep	20.83	11 250	3.120	.0130	.2225	Organic matter present, very suspicious.
10612	Driven well, city supply	4.83	0.166	1.160	.0082	.0175	Very pure water.
10614	Well, 80 feet deep.	4.50	0.330	1.830	.0166	.0109	Very pure water.
10615	Artesian well.	9.58	0.500	6.460	.0100	.0575	Good pure water, but rather hard.
10618	Well, suspected	14.83	3.000	6.830	.0233	.2050	Wholly unfit for drinking.
10622	Well, suspected	10.66	1.700	2.660	.2130	.2325	Dangerous for drinking.
10623	Cistern water	9.42	0.170	2.380	.0082	.0675	Good pure water.
10624	Surface well	8.50	0 960	3.460	.0660	.0670	Good safe water.
10625	Well	29.75	2.830	23.330	.0900	.1062	Some organic contamination, suspicious; very hard.
10627	Well near cotton mills	28.58	3.000	21.660	.0000	.0562	Pure water, but very hard.
10632	Well	11.33	1.080	3.750	.0000	.0450	Good pure water.
10633	Well	8.75	1.660	3.920	.0060	.0412	Good pure water.
10639	Artesian well	9.80	0.625	4.170	.0066	.0350	Good water.
10640	Well	2.00	0.250	0.500	.0383	.0300	Very pure water.
10641	Well	2.33	0.250	1.000	.0300	.0650	Good pure water.
10642	Artesian well	3.42	0.290	1.170	.0066	.0212	Pure water.
10643	Well	6.70	0.200	1.700	.0233	.0175	Pure water.
10674	Artesian well	12.50	0.330	8.580	.2130	.0175	Good water, but hard.

CHEMICAL ANALYSES OF DRINKING WATERS—CONTINUED.

Experiment Station Number.	Description of Water.	Grains per U. S. Gallon.			Parts per Million.		Remarks.
		Total Solids.	Chlorine.	Hardness. Equivalence in Carbonate of Lime.	Free Ammonia.	Albuminoid Ammonia.	
10675	Artesian well, 52 feet deep	13.92	0 290	10.580	.1000	.0550	Safe pure water, but hard.
10676	Driven pump	2.83	0.330	1.170	.0000	.0850	Safe pure water.
10677	Driven well, 45 feet deep	2.25	0.330	0.660	.0282	.0300	Very pure water.
10678	Artesian well, 115 feet deep	10.00	0 375	6.830	.0530	.0075	Very pure water.
10679	Well	28.00	2.870	18.080	.0033	.0425	Pure water, though very hard.
10680	Well	13.83	0.500	9.500	.0066	.0875	Safe pure water, though hard.
10681	Well near cotton mills	3.66	0.330	1.000	.0166	.0550	Pure water.
10682	Cistern	5.83	0.170	3.830	.0000	.0537	A pure water.
10683	Well, suspected	36.92	9.330	11.920	.0000	.0862	Nitrogen present as nitrates, suspicious, hard.
10685	Well, from yard convict quarters	15.45	4.080	4.580	.2600	.0650	Contaminated with organic matter, suspicious.
10687	Driven well	7.92	0.790	2.660	.0000	.0000	Exceedingly pure water.
10688	Spring	16.00	3.250	3.660	.0833	.0450	Fairly pure water.
10690	Spring	2.50	0.170	1.000	.0800	.0275	Pure safe water.
10691	Spring	2.08	0.170	0.920	.0233	.0275	Very pure water.
10692	Well, 10 feet from dwelling	9.00	2.420	2.580	.0460	.0925	Slight contamination.
10693	Well	13.50	0.660	9.920	.0460	.0325	Pure safe water.
10697	Pump near house	3.50	0.210	0.830	.0000	.0150	Very pure water.
10699	Surface spring	2.92	0.170	2.500	.0500	.0875	Slight organic contamination.
10700	Surface well	13.66	2.750	3.000	.0233	.0250	Very pure water.
10702	Artesian well	5.00	0.375	2.750	.0566	.0050	Very pure water.
10703	Artesian well	6.42	0.330	2.080	.0366	.0050	Very pure water.

10705	Well, near kitchen	7.33	1.670	2.250	.0730	.0612	Nitrogen present as nitrates, may become dangerous at any time.
10706	Well, 30 feet deep	1.50	0.250	0.830	.0130	.0275	Very pure water.
10707	Well, 43½ feet deep	24.75	0.250	13.920	.0130	.1125	Quite hard, suspicious on account of odor.
10712	Surface well, suspected	7.00	0.830	3.000	.0300	.0400	Nitrogen present as nitrates, may become dangerous at any time.
10713	Surface well, suspected	8.08	0.830	3.330	.0100	.0350	Nitrogen present as nitrates, may become dangerous at any time.
10715	Pump, private house in city	1.08	0.170	1.170	.0033	.0100	Very pure water.
10716	Well, private house in city	3.42	0 290	1.080	.0249	.0350	Good, pure water.
10718	Surface well	2.67	0.120	0.920	.0149	.1375	Disagreeable odor, very suspicious.
10721	Well, public institution	5.83	0.330	2 920	.0066	.1300	Some organic contamination, suspicious.
10727	Driven well, 26 feet deep	137.70	56.420	34.580	.0216	.1100	A very decided mineral water.
10729	Public well in a city	11.50	1.330	3 330	.0660	.0600	Indications of decomposing animal matter, foul odor.
10730	Surface well	3 66	0.330	1.000	.0166	.0550	Pure water.

Notes on the Table.

No. 10554—Sample from driven well two and one-half miles from town; water-shed uncontaminated.

No. 10582—Artesian well, located in a valley; supply for a town.

No. 10583—Sample taken from a flowing "tube well" in decomposed granite; well is 49 feet deep, with a water-shed free from all contamination.

No. 10615 is from a well 62 feet deep with 60 feet of three inch iron pipe passing through eighteen feet of sand, a crust of hard rock, then soft rock for forty feet, then into hard rock three feet, when a pocket or hollow was found, the drill dropping twelve inches and giving an abundant supply of water. Water in pipe stands 6½ feet from surface.

No. 10639—Artesian well; supply for a town.

No. 10642—Sample was taken from a well two and one-half miles from a town; well flows about ten gallons per minute—temperature 60°. Water is delivered about four feet above ground.

No. 10674—From an artesian well 74 feet deep; water overflows continually.

No. 10677—From driven well; overflows at the rate of about two gallons per minute; depth 45 feet; located on hill near branch.

No. 10678—From driven well, 115 feet deep; flows fifty gallons per minute; has been flowing for about two years and is main supply for a town.

No. 10687—From artesian well 42 feet deep; flows two feet above surface of ground; 900 feet from nearest building.

No. 10702—From artesian well flowing 2½ gallons per minute. Near a city; depth 30 feet.

No. 10703—From an artesian well flowing two gallons per minute. Near a city; depth 30 feet.

No. 10706—Is from a dug well 30 feet deep. It is lined with 12 inch vitrified tile and all joints except two at bottom are cemented. There is a stone reservoir 6 feet deep at base of tile.

No. 10730—From a dug well about 20 feet deep, which is curbed with terra cotta tubing. A galvanized iron pump is used.

It must be remembered that the remarks in regard to the purity or impurity of the samples of water mentioned in the table, refer to the chemical examination only, and do not necessarily mean that a biological examination would have justified the chemical interpretation in every instance.

In many cases the proper information in regard to kind and depth of well, sanitary conditions, and nature of the soil and underlying rock, has been wanting, and on this account the proper record could not always be made.

The following is a copy of the directions which the Station sends to those who wish to have drinking water analyzed :

DIRECTIONS FOR TAKING SAMPLES OF DRINKING WATER.

TO BE FORWARDED (EXPRESS PREPAID) TO THE N. C AGRICULTUAL EXPERIMENT STATION AT RALEIGH, FOR ANALYSIS.

Parties desiring a chemical examination of the waters of public or private wells, must first write to Dr. R. H. Lewis, Secretary State Board of Health, Raleigh, N. C., for permission to have such analysis made, and for one of these blanks, which must be approved by him. They must also state reasons for suspecting the water to be unhealthy. They should then obtain a sample according to the following directions : Secure one or more new demijohns or glass bottles, which should hold at least one gallon of each sample. Stone jugs must not be used, and when this requirement is not observed, no analysis will be made. Cleanse the bottle or demijohn thoroughly with hot water, then rinse several times with the water to be examined ; fill, cork tightly with NEW CORKS thoroughly rinsed, and tie securely down ; wax, putty, plaster or similar material should not be used for the purpose of sealing the bottle or demijohn.

In the examination of public water supplies, the sample should be drawn from a hydrant in direct connection with the main, and not from a cistern, storage tank or dead end of a pipe. In the case of pump-wells, a few gallons of water should be pumped out before taking the sample, in order to remove that which has been standing in the pipe.

It is important that with each sample a record be made of those surroundings and conditions which might influence the character of the water, particularly in reference to sources of pollution, such as proximity to cess-pools, sewers or manufacturing establishments. Where it is possible, some information should be given concerning the rock formation of the locality, that is, whether it is linestone, granite, sandstone, etc.

Mark each sample with a designating number, and if the same sample is put into more than one bottle, be sure to put the same mark on all bottles which are alike. Pack in saw dust, or other packing, and *prepay express charges to Raleigh.* The analysis will be made free of charge, but neither the Experiment Station nor the State Board of Health has funds with which to pay express charges. Demijohns are returned without expense to sender when this is requested.

Having sent the samples directed to THE EXPERIMENT STATION, with your own name marked upon the package to designate the sender, fill out and send by mail the opposite blank. Samples sent during the winter run great risk of freezing and bursting the bottles.

The analysis will be made at a time when it does not conflict with the regular work of the Experiment Station. There will oftentimes be delays for this reason. This is especially the case during the fertilizer season in the spring and fall.

In the case of wells the following additional information should be given : Depth of well ; depth of water in well ; how lined, and whether it is an artesian, driven or dug well.

Bulletin No. 162. March 22, 1899.

THE NORTH CAROLINA

Agricultural Experiment Station

W. A. WITHERS, A.M., Acting Director.

Farming in North Carolina

Being some Hints as to the more profitable use of the Soil and Crops of the State

W. F. MASSEY

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D	President of the College.*
W. A. WITHERS, A.M	Acting Director and Chemist.*
F. E. EMERY, M.S	Agriculturist.*
W. F. MASSEY, C.E	Horticulturist.*
COOPER CURTICE, D.V.S., M.D. (1)	Veterinarian.*
G. S. FRAPS, B.S. (2)	Assistant Chemist.
J. A. BIZZELL, B.S	Assistant Chemist.
H. W. PRIMROSE, B.S	Assistant Chemist.
ALEX. RHODES	Assistant Horticulturist.
C. W. HYAMS	Assistant Botanist
J. M. JOHNSON, M.S	Assistant Agriculturist.
B. S. SKINNER	Farm Superintendent.
J. M. FIX	Secretary.
C. M. HUGHES, B.E	Clerk.
MRS. L. V. DARBY	Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M	State Chemist.
C. B. WILLIAMS, M.S	Assistant Chemist.
C. D. HARRIS, B.S	Assistant Chemist.
F. G. KELLY	Assistant Chemist.
W. G. HAYWOOD, B.LITT	Assistant Chemist.
H. E. KING	Chief Clerk.
MISS M. S. BIRDSONG	Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them. *Samples for analysis should be sent to the State Chemist.*

* Member of Station Council.
(1) On leave of absence.
(2) On leave of absence. The duties are performed temporarily by J. M Pickel, Ph.D.

FARMING IN NORTH CAROLINA.

BEING SOME HINTS AS TO THE MORE PROFITABLE USE OF THE SOIL AND CROPS OF THE STATE.

W. F. MASSEY C. E., Horticulturist.

INTRODUCTORY.

It may be well said that the farmers of North Carolina "are confronted by a condition and not a theory." The short-sighted policy of the past has placed a large portion of our soils into a very unproductive condition, and the problem that confronts every thoughtful farmer is how to restore and to retain the productiveness of the wasted soils. The idea that a soil orginally fertile, and of such a nature as to retain fertility, can be permanently worn out by cropping, we believe to be an error, and we believe that the unproductive condition of much of our clay soils is the result of poor culture, and that they still retain a large portion of their former fertility if properly treated. Of course there are large areas of soils that were naturally thin in the beginning, and these have rapidly been exhausted of their little store. Many deep sandy soils that formerly had a moderate store of vegetable matter have been reduced to absolute barrenness, and these soils being of a leachy nature are the hardest of all to retain in a permanent state of productiveness. But such soils constitute but a small part of our domain. Over a large portion of the state there is a subsoil of the deep red clay peculiar to the piedmont region east of the Blue Ridge mountains, which, when properly treated, is a soil of almost inexhaustible fertility, but which in many places has been so badly treated that it has reached a very unproductive state, and large areas have been turned back to grow up in broomsedge and pines, which under a fairly systematic cultivation might have been retained in a highly productive state for an indefinite period.

Then in the coastal plain there are wide areas of level sandy soil underlaid with a compact clay subsoil, as fertile in its nature as the red clay of the uplands, but which through the slovenly scratching of the past has become very unproductive, but which is the easiest of all the soils of the state to redeem and to maintain in a productive condition if any proper system of farming is adopted in place of the old time planting year after year in a single crop. Then, too, we have in the state large areas of black, peaty soil, that has been reclaimed from swamp, and larger areas of the same that

may still be reclaimed from swamp conditions. Much of this soil is of almost inexhaustible fertility even under the slack system of cultivation to which it has been subjected. But there is with these black, peaty soils a right and wrong way, and the right way is to so cultivate and change their character by proper treatment as to retain and increase their natural productiveness to a point far beyond what they have been made to do. It is with the hope that we may be able to throw out some hints that may aid the thinking farmers of the state in the improvement of their land that we write this bulletin, for it is the duty of the Experiment Station to do all in its power to disseminate information on all subjects connected with agriculture and horticulture. And I would say here that we will be always ready in the future, as we have been in the past, to aid the farmers of the state by answering their letters on any subject that interests them.

THE ERRORS OF THE PAST.

Over a large portion of the state the soils lie on rolling uplands. When these hills were first cleared from the forests that covered them, the soil filled with vegetable decay, responded readily to the crudest cultivation. The hills did not wash, because the soil was filled with the roots and other vegetable matter that prevented this. But the planting system of the past simply went to work to rob the land of all the fertility available by the shallow preparation in vogue, and kept the land in constant clean cultivation in cotton or tobacco or corn, restoring no vegetable matter to the soil, but fighting grass as an enemy. The humus accumulated in the long ages of forest growth was exhausted and the mellow top soil, underlaid by a compact clay which the little plow had not touched, filled with the water of the heavy rains, ran off the surface and exposed the red clay beneath. The winter frosts mellowed the surface of this clay and the rains washed it, too, away. Thus the hillsides became red galls and later on deep gullies, carrying down their load of soil to the bottoms and to fill the streams, until the rivers that formerly ran clear and sparkling to the sea now carry away in their turbid flood the fertility of the soil. Many of the steeper of these hillsides should never have been cleared from the forest, as the forest cover was the best thing for them, and the best for the lowlands as restraining the rapid rush of water and retaining it to gradually percolate into the land below. Through the waste of the past we have now in many places acre after acre of these galled and gullied red hillsides, the greatest problem that the farmer has to face in their redemption.

But it is not in the steep red hills only that the improvident methods of the past have made waste of the soil. In sections where

the soil is light and sandy and the surface only moderately undulating, this robbing of the humus from the soil has caused a washing and gullying into the mellow yellow subsoil of these lands that is almost as bad in some places as the red gullies of piedmont. These lands did not wash at all when first planted in cotton, for the soil was full of vegetable decay, and they only began to wash after the land had been robbed of this through long years of cotton cropping. In some places the black lands have sunk through the same treatment and have become unproductive for anything but rice. The evident remedy is to practice some method by which the former new ground conditions can be restored to our soils. The question is then how to do this in an economical manner, and how to keep these conditions after we have attained them. All over the South we can see how nature left alone does this. The old field, turned out as exhausted and worthless, soon covers itself with grass and weeds to hide the waste that man has made and to teach him what he should have known, that a soil constantly uncovered, rapidly loses its productiveness. The broomsedge soon waves over the land and adds its annual decay to the soil, unless some thoughtless fellow burns it. Then in the shelter of the broomsedge the pine seed, blown by the wind, finds favorable conditions for its germination and growth. It sends its subsoiling tap root down into the fertile subsoil which the man who scratched over it last did not dream of being there. But down in the store of plant food in that untouched and virgin soil the pine roots penetrate and draw up food for their growth. Year after year the pine sheds its crop of leaves on the ground, adding to the surface the mineral matters it has drawn from far down, and a new soil is gradually formed from the vegetable decay. The broomsedge and the pine have been the salvation of the southern lands, rescuing them from absolute sterility, and year after year teaching to man the lesson of the method for the improvement of these soils. But the lesson has not been heeded, and after the pine has for generations been engaged in the restoration of the soil, some man comes along and clears it off and finds a new and productive piece of land on the old abandoned field, and at once goes to work to rob the soil again of what nature had so patiently accumulated there to give him a fresh start and to teach him how to maintain the fertility she gives. It is the restoration of these new ground conditions that should be the aim of the soil improver. He should try to imitate nature's method, not in the long and tedious way she does, but to enable her more rapidly to accomplish the work she would do if left to herself with the broomsedge and the pine. Man working with nature instead of against her can accomplish wonders in the recuperation of the worn areas. The problem, then, that is before us, is how we can best aid nature in the work of restoring the productiveness of our soils.

COMMERCIAL FERTILIZERS. THEIR USE AND ABUSE.

From all over the state we are in constant receipt of letters asking for formulas for mixing fertilizers for this, that and the other crop. Men write that they have a piece of land that made a little crop of corn or cotton last year, and they want to know how much fertilizer they must use to make that same piece of worn land produce a big crop of the same thing. The only idea that many seem to have in regard to the cultivation of the soil seems to be that the soil is only something to place fertilizers in, and that for every crop they plant they must buy some fertilizer. As we have time and again remarked, their whole idea of farming seems to be reduced to a mere matter of gambling on the chances of getting a crop enough to pay a profit over the cost of a little fertilizer. We have no antagonism to commercial fertilizers, for when properly used they are efficient aids in the restoration of our soils and in their permanent conservation of fertility. But, *as they have been used in the South,* commercial fertilizers have been the ruin of farms and farmers alike. The idea that each crop planted on the farm must have its due allowance of a concentrated plant food, is largely due to the experiments that have been made in the stations in studying the effects of the different fertilizer mixtures on the different crops, so that the farmers have come to the conclusion that with every crop planted there must be a dose of fertilizer applied that has been found best adapted to its growth, no matter what the condition of that particular soil may be. Our farmers have lost sight of the fact, or perhaps never realized it, that by adopting a system that tends to conserve and retain fertility there is no need for the application of fertilizers to every farm crop grown. True, their production may be increased by such an application and an apparent profit shown, but what we are now after is to show that the farm can be made to improve itself by rational methods, and at the same time give constantly increasing crops while paying for its improvement. While the use of commercial fertilizers in a complete form on every crop grown may increase their product as we have said, the chances are that any such plan will be found an extravagant and wasteful one for the ordinary crops of the grain or cotton farm. Hence, as we do not propose in this bulletin to give any fine spun theories, but to aid the farmer who really wishes to improve his land, in doing it in an economical manner, we do not propose to give a list of formulas adapted to this or that crop, but simply to treat of the use of commercial fertilizers in the proper improvement of the soil for any or all of the crops.

HOME MIXING OF FERTILIZERS.

Fertilizing matters being a necessity in the recuperation of the soil, their making is a matter of much importance, and the farmer should know just what he is using and no longer buy his fertilizers on "the patent medicine plan." By buying the materials and mixing them at home in the proportions he needs, he can always be sure of having what he wants and of getting it at a much lower rate than the same value could be had from the manufacturers. Some short-sighted fertilizer manufacturers are trying to prevent the farmers from getting the chemicals and doing their own mixing. But they are working against their own interest in this, for the home mixing of fertilizers is going to be the rule in the future, and the sooner the fertilizer men realize it and put all the facilities in the way of the farmer's getting what he wants the more they can make by sales of these things. It has been abundantly proved at more than one station that home mixed fertilizers give just as good results as the same grade of factory mixed goods and cost far less.

OUR PIEDMONT RED CLAY AND ITS IMPROVEMENT.

All over the southern portion of the rolling uplands of the state east of the Blue Ridge there are thousands of acres that have been washed and almost ruined for any use by the cultivation year after year of cotton on soils of this nature. These rolling uplands were never intended by nature for the clean culture of cotton. They are naturally well adapted to the culture of the grains, grasses and clover, and to the rearing and feeding of stock. It is true that under a rational system of farming cotton might have been profitably grown on these lands at former prices. But the real cotton lands of the state, and the ones to which cotton should be relegated, are the coast plain level lands. The rolling uplands will bring more money in grain, grass and stock than in cotton at present prices, and there is little prospect for its being any higher in the years to come. Hence, while in some sections of the piedmont country it may still be well to keep cotton in the farm rotation, in a large part of this region the crop should never have been grown, and the country would have been far better off to-day if it had not been grown there. All through the region west of Charlotte there are thousands of acres that are devoted to cotton which would have been far better to-day had not a plant of cotton ever been planted there, for the hills then might have been covered with sod and made to feed countless cattle that are now brought from elsewhere to feed the towns. This is an abundantly watered region, and nowhere would the dairy conducted on modern lines be more profitable or do more for the improvement of the land. The rolling hills should be kept in

grass as long as possible to prevent washing, and when the grass fails the soil should be thoroughly prepared and gotten back to grass as soon as possible, and only the more level lands devoted to regular cropping. With the hill lands full of grass roots every time they are plowed, there would be little danger of washing until they get back in grass once more. In all efforts to improve these rolling uplands the idea to keep in view is the restoration of the new ground conditions they formerly possessed by a systematic restoration of the wasted vegetable matter.

In the starting of the improvement of a worn farm in the piedmont red clay, the first thing is to get the land into the proper mechanical condition. Proper breaking and rapid cultivation are worth more in these lands than all the commercial fertilizers ever mixed, for bear in mind that that deep red clay is all fertile soil down to the rock from which it was formed. It is full of plant food and only waits to be exposed to the oxidizing influences of the air to be made productive. This is no theory, but a fact we have proved experimentally. Years ago we had a piece of land of a number of acres in the foothills of the Blue Ridge that was formerly a sharp hill top, but had been graded off full fifteen feet perpendicularly to make a broad plateau for lawns and buildings. The wide stretch of bare red clay was then deeply broken with plow and subsoiler and made a fine bed 15 inches deep. After the frosting of one winter it was sown to blue grass, and no better grass could be found than grew right there. In the preparation of the lawns at our college here in Raleigh, we were in a hurry to see some grass around the building, and rather hastily prepared the soil that had been scratch plowed for generations, fertilized it and sowed seed. On part of the lawn there had been a well that was used during the building of the college, and which we had filled up. But all round the old well lay the red clay that had come from it. On this red clay was the only place we got any stand of grass at all. We then went to work and broke into the red clay all over the space and sowed the land one season in cow peas to restore some vegetable matter, and then prepared the soil and seeded to grass and got a lawn that has been the admiration of every one for years.

These red clay hills have for generations been scratched, many places never having been plowed by anything heavier than a single mule. The hills have washed largely because there was no place for the water to go but to run off the surface and carry with it everything loose. The first thing then to be done in its improvement is to break it. There are soils in which we would never advise deep turning, but the red clays of upper piedmont are not of this character, for they can not be plowed too deep if the plowing is done at the proper time and in the proper condition of the soil. Of course the deep turning must be a gradual thing, for while the subsoil has

a great deal of latent fertility it needs the influence of the air and frost for a while to make it mellow and easily cultivated and the addition of vegetable matter which is deficient in it. But while the turning need not at first be very deep, the breaking should be always deep through the use of the subsoil plow that runs in the furrow made by the turning plow and loosens up without turning the subsoil lower down. In this way we can get the soil loosened to a depth of 15 inches. The red hills have been washing as we have said because there was nowhere else for the water to go. But when we have loosened a bed of soil 15 inches deep, it will take a cloudburst to start it to running, for the mass of loose soil will retain a large rainfall without any wash at all. This deep preparation should always be done in the fall in preparation for some winter crop like small grain. The land is then generally in the best condition for the subsoiling, and it is seldom in fit condition to do this work in the spring. But while deep preparation is always best done in the fall we must guard against the too common practice of leaving plowed land bare all winter. Our lands have deteriorated more through being left without a cover of plant growth in winter than they have from the summer cropping. In the far North, where the soil freezes up all winter, it may be a good practice to plow the land in the fall in preparation for the spring crops, so as to get ahead with the work that crowds them in their short spring. But here where we have more rain than frost the land leaches its fertility very rapidly in winter when exposed. The nitrogen escapes rapidly from such a soil in winter when uncovered, but when there is a soil cover of growing crops of some sort there is hardly any appreciable loss. The keynote to all improvement in our uplands is to never allow them to be exposed without a plant cover at any time except during the culture of the hoed crops in summer. A soil cover of vegetation is one of the essential matters to the improvement of the soil.

Assuming that our upland farm is to be devoted to the culture of grain and the feeding of stock we will now say something in regard to the proper culture of such a farm. We will assume that in its present condition, though it may really have a store of latent plant food in it, it is in that proverbally poor condition "too poor to sprout peas." Very little if any of such land is in that condition, but it expresses what we wish to begin with, a soil that has been so badly used as to be in a condition of utter unproductiveness. In the beginning with such a soil it will be necessary to start its improvement with the use of some of the fertilizer mixtures. We will assume that the deep preparation mentioned has been made, and that by repeated harrowings we have gotten the surface soil into that fine condition and well packed state that the wheat crop requires. For the wheat we will use 300 lbs. per acre of the following mixture: Acid phosphate, 1200 lbs.; cotton seed meal, 600 lbs.;

and muriate of potash, 200 lbs. This will make a ton of complete fertilizer, which at this stage of the improvement will be needed to make a crop, but we will find later on that both the cotton seed meal and the potash can be dispensed with in soil of this character by proper management.

We now seed the field to wheat, using five pecks of seed per acre, and putting it in with a drill, always following the contour lines of the hill with the drill to prevent washing. The crop should be a fair one with this treatment, and as soon as the wheat is off we give the land a dressing of acid phosphate alone and at once sow it in cow peas. In August or early September these will give us a fine crop of hay. Do not be deluded with the idea of what is called "green manuring," but always make every food crop into cured feed for cattle. It was shown at the Alabama station that an acre of cow peas gave a profit of $10.50 in pasturing them off with hogs, and a large part of the plant was left in the soil with the droppings of the animals. But with the fertilization proposed, the crop of hay should be worth fully $20 per acre for feeding purposes. No prudent farmer can afford to bury so much food in the soil as green manure, especially since by the proper feeding of it and the careful saving of the manure he can return to the land a large part of the manurial value of the crop in a better shape for plant food, while he has made another profit in the feeding of the stock.

After the peas are cured for hay, chop the stubble up with a disc and sow crimson clover on it at rate of 15 lbs. per acre to make a winter soil clover. If the clover fails, then sow rye for this purpose. During the fall and winter get out all the home-made manure and spread it broadcast on this field as far as it will go, and in spring turn under all the rye or clover with the manure for the corn crop. The corn tend is the place for the accumulation of barnyard manure. It is the place in the rotation where it will do the most good in the permanent building up of the land. We have experimented with commercial fertilizers on the corn crop, and experiments of the same kind have been made at other stations, and we have never seen an instance in which the increased crop paid for the expenditure. Of course there is an increase usually in the crop from such application, but when compared with an unfertilized plot it will be found that the increase does not pay the cost of the application at the price the corn usually commands. Having then prepared the land for corn, let us at once resolve to abandon at once and forever the practice of deep cultivation of the corn crop and the murderous hilling with plows. The plowing for the corn should be deep and thorough, but all subsequent culture should be shallow. For the first cultivation of the crop the best tool is a slant-tooth smoothing harrow run over the whole ground just as the corn comes up. All subsequent cultivation should be with a cultivator run shallow as

possible, and run often enough to keep the surface inch or so always mellow till the corn is too large to get through. Never under any circumstances tear the roots of the corn by deep working, and never under any circumstances take a turning plow into a cornfield after it is prepared for planting. The hilling of the corn is not needed to support it against wind, for the cutting of the roots in hilling makes it easier to blow it down, and the brace roots get a better hold on a level surface than on a sloping bank. Deep preparation and shallow and frequent cultivation is the rule for big corn crops. When you have fed cattle enough from the increasing amount of forage you will have from the peas and corn fodder, and raise manure enough to give the cornfield a light dressing all over, it will easily carry the corn crop and the following crop of winter oats. As soon as the corn is well glazed and while the fodder is still in good condition, cut it off at the ground and cure it in shocks, and thus clear the field so that the oats can be sown in September. This oat crop we will again follow with cow peas the next summer, cure them for hay and get the land in order for wheat again, thus completing a three-year rotation. By this time, if the peas of the second crop have another dose of acid phosphate, the wheat can be made without further addition of fertilizer, and the land should be able to grow clover. When it comes to the point where we can get a good stand of clover after the wheat, we would abandon the oat crop and make the rotation corn, wheat and clover, using the cow peas only in the corn. Or if it is found desirable to continue the oat crop, the rotation can be profitably lengthened so as to include a year of clover after the wheat. In this case the corn will have the benefit of a sod of clover in addition to the manure, the oats will follow the corn, peas after the oats, and wheat after the peas, seeded to clover. This rotation will probably be the very best that could be contrived for such a farm. It will give an increasing amount of pea-vine hay and clover hay and also of corn fodder.

If it be found that on such a farm the stock interest becomes of the leading importance, as it may well become, with the large amount of forage grown, the larger part of the corn crop should be used for making ensilage or the cured fodder and stalks should be shredded to make feed. Finally, after the second or third round of such a rotation it will be found that the only place that there is any need for commercial fertilizer will be on the pea crop in the shape of acid phosphate. Then if the clover in its second spring after sowing has a dressing of lime at a rate of 30 bushels of slacked lime per acre once in six years, it will be found that the abundant potash in that soil will be made available and there will be no need for any artificial application. Such a system, with the deep fall plowing and subsoiling kept up, will rapidly deepen the productive soil, and the farm will increase in productiveness while decreasing in the expense of fertilizers.

ON A COTTON FARM.

On a farm in the same region where the cotton crop is to be retained as the money crop, we would make the rotation a three-year one and would use the cow pea entirely in place of clover. In this case the cotton would follow on the pea stubble of the previous year. The commercial fertilizer used at first should be a complete one like that recommended for wheat in the start, and the cotton seed of the previous year should be buried in the middles to rot and be reached by the roots just when they need them most, at fruiting time. After the last working, and while the soil is still fresh, the cotton field should be sown in crimson clover for a winter soil cover. On this clover during the winter get out all the farm manure for the corn crop and spread it broadcast. Plow clover and manure in the spring and prepare and work the land as advised for the corn crop before. Cut this corn and cure in shock and put the land in oats in September without breaking again, but merely fining with a disc harrow. Follow the oats with cow peas and make them into hay to feed to stock. In this rotation the peas should have a liberal dose of acid phosphate and potash at first, and afterwards only the phosphate. Lime should be used once in six years on the corn land just before planting and left on the surface to be worked in in cultivation. Lime will liberate the potash in the clay and will also promote the nitrification of the organic matter buried in the soil. In a little while by this rotation and a liberal application of acid phosphate to the peas, it will be found that the cotton crop can be grown without any further addition of fertilizer, the peas giving plenty of nitrogen, and the acid phosphate leaving enough phosphoric acid in the land. The whole idea in such a rotation being to build up the soil for the cotton crop, and in doing it to increase the production of every crop in the rotation, and to do away with the necessity for the purchase of special fertilizers, by making the potash in the soil available and getting the nitrogen by the use of the peas. The growing of the peas will give an increasing amount of cattle food or they can be turned to account in the feeding of hogs on the ground and the making of bacon for profit. In the cotton country proper, the same rotation will be found the best, and there the field feeding of the peas to the hogs will probably be found the best use that can be made of a larger part of them, though some of course should be cured for the feeding of the family dairy cows.

In all the cotton country of the coast plain, the best adjunct to the cotton crop will be found in the hog and its products. The hog will profitably make use of the ripe peas and leave the land in better condition for the succeeding cotton crop than in any other way, and the home curing of the hams and bacon can be made an increasing source of profit. By sowing peas that ripen in succession it

might be profitable to lengthen the rotation another year for this purpose and grow another pea crop, dividing the field temporarily into two parts, one for an early and another for a late pea, so as to keep up the feeding for a longer time. Of course the finishing will be with corn. Later on we will have something to say in regard to the proper curing and marketing of bacon.

THE SOUTHERN FIELD OR COW PEA.

For years past we have been urging upon the attention of the southern farmers the great value to them of the cow pea, when properly grown and cured as a forage plant, and we are glad to know that through our efforts the cultivation of this valuable legume has widely extended in the South, and the fact has become manifest that when gradually acclimated northward, the cow pea can be grown successfully far north of the line where its success was formerly thought impossible. The cow pea has not inaptly been called the Clover of the South, and the fact is that it not only takes easily the place of the clover in the South, but in value as a food crop and a soil improver it far surpasses clover not only in the South, but will do for the Southern farmer more than clover will do in the North, but will do it in less than half the time and with much more certainty. Clover often fails even in the North, and is a failure commonly in the South, except in the upland clays of the piedmont section. The cow pea never fails when sown at the proper time, and its rapidity of growth and immense production of valuable forage, fully equal to the best clover for hay, put it far ahead of the clover for the use of the Southern farmer. Then, too, in the first start towards the restoration of a worn piece of land the pea can be depended upon to grow and make a crop on land where clover could not be induced to make any growth whatever.

But there are many erroneous notions in regard to the pea and its value as a soil renewer. Some years ago, one of the correspondents of a farm paper that circulates all over the South, wrote to the editor that he was satisfied that all this talk about the cow pea improving land was pure humbuggery, for he had raised peas on a piece of land for twelve years in succession and the land finally got so poor that it would not grow peas. This shows what peculiar notions some of our Southern people have in regard to the soil and plant-life. The growing of any plant under the sun for twelve years in succession on the same piece of land, and removing the crop will of course exhaust the productiveness of that land, especially for that crop. The pea being such a greedy consumer of phosphoric acid, lime and potash, would doubtless exhaust the land under such circumstances as fast as any plant that could be grown, always taking the same things in the same proportions until the supply of these

things available in the surface soil runs out, and then, of course, the crop fails. The pea will enable us to get nitrogen from the air as no other class of plants except the other members of the pea family will. Nitrogen, when purchased in a commercial fertilizer is always the most expensive part of a complete fertilizer, costing about as much as the other ingredients of the fertilizer together.

A crop of peas of average production will leave in the soil about as much nitrogen in the shape of organic matter and nitrates as we would get in a ton of ordinary fertilizer. Hence a plant that will do this for us is doing all that we can expect any plant to do. But in order that the pea may do this for us, it must have the mineral matters in the soil in sufficient amount and in a readily available condition. It must have an amount of available phosphoric acid, potash and lime sufficient to enable the plant to make its best growth and to develop its capacity for the fixation of nitrogen in the most complete manner.

HOW THE PEA GIVES US NITROGEN.

It has long been known that plants belonging to what Botanists call the family of Leguminosæ had in some way the power to acquire and use nitrogen that did not exist in a combined state in the soil. Some asserted that the plants absorbed the nitrogen from the air by means of their leaves. But later investigations have shown that the work of nitrogen catching is not done by the peas or clover or other legume (a legume is a plant of the fruit of which is a legume or pod, hence the name for all the family is Leguminosæ or pod bearers). The real work of getting the nitrogen of which the air is largely composed in the form of a free gas, is done by certain microscopic plants that attach themselves to the roots of this class of plants as parasites. The parasitism, however, in this case is not a harmful one, since the little organisms that feed on the nitrogen gas that penetrates the soil give more to the roots than they take, and the process is a sort of symbiosis, or living together for mutual advantage, rather than a parasitism that is harmful. These little plants, consisting of single cells of living matter, have the wonderful power that no green plant has of feeding on the nitrogen gas, and through this feeding or oxidation of the nitrogen forming nitric acid. Now when an acid is formed in the soil it at once finds some base, such as lime, potash or magnesia, and is transformed into what is called a salt of these substances and the result in this case is the formation of nitrates of potash, lime or magnesia, which green plants like the clover can at once absorb and use in their growth, for it has been proved that all forms of nitrogen in the soil must be changed into nitrates before the green leaved plants can use it. In this process of the formation of nitrates by

the little plants that exist on the roots of the pea, the pea is enabled to take up and store away in its growth a large part of the nitrates formed, and the soil also gets fixed in it in the same form more than the pea takes up and the nitrogen content of the soil itself is increased.

Now when the pea crop is harvested as hay, a large part of this nitrogen is taken in this hay. But in feeding the hay by far the larger part is recovered in the droppings of the stock, and if this is carefully saved and applied, we lose but a small part of the manurial value of the pea, while at the same time we can get the feeding value to make a profit out of in the stock. Another part remains in the roots in the form of organic matter, and this part must go through the process of what is called nitrification in the soil before it becomes available for the growth of other plants that follow the pea. This keeps it in the soil until the following summer, when it rapidly becomes available for plants by changing into the available form of a nitrate.

This process of nitrification in a soil abounding in vegetable matter is brought about by other forms of microscopic plants that flourish in such a soil. Thus a soil abounding in organic matter in a state of decay can readily be called a living soil, while one in which the humus or organic decay has been used out of is really a dead soil. As soon as the dead pea roots are left in the soil, the bacterium of decay sets to work to break down the organic matter and to release the ammonia. Then another form of bacterium takes up the work and changes the ammonia into a nitrite, still another form then changes the nitrite into a nitrate which green plants can use. It has been found that the presence of the carbonate of lime in the soil rapidly hastens this nitrification, and it has further been found that these little organisms have another power that green plants do not possess, of taking from such a combination the carbon they need for their growth. Green leaved plants get their carbon through the decomposition of the carbonic acid in the air, by means of the green matter in the leaves, but these little microscopic plants in the soil get it directly from the carbonate. This explains the way in which an excess of lime in a soil abounding in vegetable decay hastens the process of nitrification or change of organic matter into the available form of a nitrate for the use of the green plants.

We must understand, then, that while the pea will get us plenty of nitrogen in the most available form, it cannot get from the air the mineral matters that are required in its growth. Fortunately, these mineral matters are more easily retained in the soil than the nitrogen is, for while nitrogen in the form of a nitrate very easily escapes from the soil in the drainage waters, the absorptive power of a clay soil enables it to take hold of and retain for the future use of plants the phosphoric acid lime, potash and other matters that

plants need. These are more slowly exhausted. But they are exhausted from the upper soil by the improvident scratch culture of generations, and the soil becomes unproductive. It is right here that the better preparation of the soil by deep plowing and cultivation come in to remedy the mistakes of the past. Into the deeply prepared land the pea is enabled to push its roots and to draw up into the surface soil the mineral matters that are abundant in some of the untouched subsoils, and in this way it can restore to the surface soil much that has escaped beyond the reach of the shallow plowing in the past.

But in many of our soils there has been a real exhaustion of a large part of these minerals, and as we can never get them from the air we are compelled to get them in the form of acid phosphate and potash. The deficiency of these being made good by the application, the result is a largely increased growth of the pea, a larger crop of forage and a larger root development, and hence a larger nitrogen collection. It should then be plain to any one that the mineral fertilizers applied to the pea crop are right where they can exert the greatest influence in the permanent improvement of the soil. The larger the forage crop, the more feed we have for the domestic animals. The more animals we feed well, the more manure we can make and of a better quality. The more manure we make the greater our corn and other crops become from its use, so that it is a progressive ratio all around, for the feeding crops on the farm are the ones that tend more than any other to the increase of the humus in the soil and the increase in the activity of the nitrifying organisms that feed on this organic matter.

Lately there has been an effort on the part of some who imagine that they are in this way helping the sale of commercial fertilizers to decry the value of humus or decayed organic matter in the soil, and the editor of a certain paper devoted to the fertilizer trade has advocated the use of fertilizers only and tells his readers to "give humus a rest," as the fertilizers are all sufficient for the making of crops.

The value of humus does not consist alone in the nitrifying of the organic matter, but it has an importance in the mechanical condition of the soil that is fully equal to its plant food value. It has been found that a soil abounding in this vegetable decay has a far greater capacity for the absorption and retention of moisture than any other character of soil, and as moisture is essential to the perfect solution of food in the soil for plant growth, such a soil gives greater results from the use of the commercial fertilizers than a soil in which there is a little humus. Therefore the maintenance and increase of the humus is as important to the vender of commercial fertilizers as to any one else, and he should encourage rather than discourage the accumulation of organic matter in the soil, so that

his goods can give their best effects. Then, too, it is found that a soil abounding in vegetable matter does not bake and crust as soils do which are deficient in this respect, and such a soil does not wash so readily as others. This any one knows who has cultivated land newly cleared from a forest, where the vegetable matter is in abundance. Such soils even when on steep hillsides do not begin to wash till the vegetable matter has been robbed from them by long and careless culture. We see then the important place that the pea can take in the recovery of the new ground conditions in our own lands and any method of culture that favors its more abundant growth favors the rapid restorations of the conditions that tend to fertility and productiveness. A clay soil may have in it all the elements of fertility, but when it has been run together by long culture without the restoration and maintenance of the humus in the land it rapidly gets in an unproductive condition merely by its mechanical constitution. It fails to get penetrated by the air. Its particles are not separated by the humus, and it is hard to reduce the clods and bring out the plant food into an available state. The breaking up of this impervious condition is one of the chief benefits that the growth of the pea has upon the soil of our red clay uplands.

STOCK FEEDING THE GREAT NEED OF THE SOUTH.

But it is not in its direct action on the soil that the great value of the cow pea comes in to a great extent. We have said something in regard to the great feeding value of the pea crop. Some will say at once: If the growth of the pea is such a benefit to the soil, why not get it at once by plowing under the whole crop. Much has been written in the North especially in regard to what they call green manuring, and many there advocate the growing of crops of clover or peas for the sole purpose of plowing them under for manure. This is a very short-sighted policy anywhere and particularly in the South. The plowing under of a mass of green vegetation in a warm climate, and especially on a sandy soil, is apt to result in the evolution of organic acids to such an extent as at times to render the land so treated for a time wholly unproductive. Green manuring is wrong for another reason. If we turn under at midsummer the green growth, we cut short the nitrogen gathering the plants would do for us, for the greater part of this is done in the latter part of the plant's growth, and by turning it under green we lose a large part of the work that it would have done later on, and at the same time run the risk of injuring rather than benefitting the soil. This is so well known to many who have tried it that it is not necessary to speak further of this point. But the most important point is that we thus bury a crop worth usually at least $20 per acre as food for stock. Now it must be a remarkably profitable crop that suc-

ceeds such an expenditure of food to make this pay. On the contrary all experiments here and elsewhere have shown that the best way is to cure the peas as hay and to feed them to stock and save all the manure carefully to be returned to the soil. And it has also been proved that fully 75 per cent of the manurial value can be thus saved and that the feeding value can be fully realized in addition and a profit made from the animals fed. The slavish dependence of the Southern farmer on the fertilizer manufacturer has been largely brought about by the failure to make the feeding of stock an important part of our work. Stock feeding and the saving of manure lie at the very foundation of all successful agriculture, and the man who supposes that in the long run he can do with commercial fertilizers alone will find that he does it at the expense of the permanent fertility of the soil. The pea, aided by the application of mineral fertilizers, will give us a good deal of the organic matter that we need, but the organic matter and plant-food in the form of barnyard and stable manure have never yet been fully imitated in chemical matters alone. Where there is no profit in the feeding of stock it is true that we can bury the peas in the soil or feed them off on the ground to hogs and make the soil increasingly fertile, but there are few localities in the South where the feeding of beef or dairy animals cannot be made a profitable part of the farm work. The trouble with many is that they have been brought up to the planting idea and do not care to undertake anything but a cropping, and dislike the constant care and attention that stock feeding demands. Until we get away entirely from the old cropping idea we will never become the systematic farmers that the country needs.

CURING THE PEA FOR HAY AND STOCK FEEDING.

There has long been a notion that the cow pea is a very hard crop to save in the form of hay. The many contrivances seen all over the country for the drying of the pea vines attest the general prevalence of the idea. We have tried for some time past to tell how to cure the peas in a perfect and simple manner. But many have failed in the effort, while many others have succeeded in the making of the finest of hay. At the meeting of the North Carolina Horticultural Society at Southern Pines last summer, there was exhibited by one of the members a sample of pea vine hay that was perfectly green in color though completely dry, and had all the leaves retained, and these are the most valuable part, and the part commonly lost in the old methods of curing. Mr. J. Van Lindley, who made this exhibit, has the largest peach orchards in the state near Southern Pines. He has to keep a large force of mules for the cultivation of his orchards, and had been buying Northern hay for them, assuming

that no feed could be grown in that sandy soil. Last year he tried the cow pea and cured them as I have often recommended by putting them when half dry into a barn and letting them cure in the mass. He also cured in the same manner a large crop of peas at his home place in Guilford county. I happened there just as the first wagon load of the half-dry peas was brought to the barn, and found them doubtful in regard to storing them so green. I told them to go ahead and put them in, which was done, and a great supply of the finest hay was the result. Mr. Lindley says that he is now independent of the Northern hay for he can make a ton to the acre on the barren sands at Southern Pines. The whole method is simply to cut the peas and when they are dried enough so that a bunch taken in the hands and twisted hard shows no sap running to the twist, they will do to go in. When once in the barn, they should not be disturbed while heating, but allowed to heat and cure with as little contact with the air as possible. I was in the habit of raking into winrows and cocks, but Mr. Lindley says that he finds that when they begin to heat in cocks before storing, they are more apt to mould, and he prefers to let them lie on the ground and get to the half cured condition. The important thing is to store them while still limp, so that the leaves are saved, for these are the best part of the hay, and are commonly lost in the usual mode of drying completely outside. Care must be taken, however, that there is no dew or other external moisture on them when stored. The fact that nine-tenths of the farmers who have tried this method the past year have succeeded in making the finest of hay should encourage those who failed to try to find the reason for their failure till they too succeed, for if one man can make the best of hay by the barn cure, another should be able to do the same. The sample that Mr. Lindley exhibited was sent to the editor of the *Southern Planter* at Richmond, Va. The editor, Mr. Jackson, is an experienced English farmer, and he said in his next issue that the sample came nearer to the finest English cured hay of anything he had seen in this country. Having this valuable forage at hand, and the corn fodder to balance the ration one should be able to feed stock in the best manner. The method of compounding rations has been well treated in other bulletins from this station and to these we will refer the reader.

THE STOCK FEEDING CAPACITY OF THE BLACK PEA SOILS OF EASTERN NORTH CAROLINA.

There is no section of the state where the productiveness of the soil in materials for profitable stock feeding is greater than in the black soils near the coast. In all the region along the railroad leading from Norfolk to Edenton, there are wide areas in which

the only crop seems to be corn grown for the grain. The country along this railroad passes through miles upon miles where in the fall of the year the whole country in sight is covered with corn stalks wasting in the wind, that might under a different management be made to feed innumerable cattle. Here right where a great export business in cattle could be established from the port of Norfolk, the principal interest seems to be in the raising of corn for sale. No country ever became permanently wealthy from the export of raw materials alone. Far greater profits can be made by the conversion of the raw materials into some other form that gives greater profit. The corn of the swamp country would bring far more money in the shape of beef and pork than it does in the shape of grain sold on the market. The owners may imagine that their lands do not need the manure, but experiment will show that it will not be wasted thereon. While the rotation of crops adapted to the upper country would not be the thing for the black lands, there is nevertheless as much importance in proper farming on these lands as there is with any. The ceaseless cultivation of corn alone will certainly not improve their character nor productiveness. It would seem to an observer that here of all regions of the state is the place for the silo and for rational stock feeding. The corn stalks that annually go to waste in the country along the line of railroad east of the Dismal swamp would feed all the beef cattle that Norfolk can consume and leave some for export. With all that great corn product turned into ensilage and fed to stock there could be made a beef business for export purposes that would be far more profitable than that on the prairies, since the location is right at the export point, and this will give the feeders a great advantage even over the West. If the winter feeding of cattle is ever inaugurated there on a large scale, there will be plenty of thin Western cattle to be had, and the exporters will always be anxious to get right at their doors the cattle they need.

With the great corn crop of that region turned into ensilage, and the land at the same time sown to cow peas to be eaten off by hogs, there would be a double product that could not fail to bring in more and more of the ready cash. Packing houses for the hog product would spring up and the sale of manufacturd products bring greater wealth and population to the section. Then, if on alternate years the field is sown in cow peas of early and late varieties, and a large part saved for hay, the cattle feeding on the corn silage could have the pea vine hay or pea silage to balance the ration and make a complete food, while the pigs would be growing fat all summer on the abundant peas. With this sort of an alternation of peas and corn with an occasional dressing of lime and some phosphate and potash the soils of that region that have been reclaimed from swamp conditions would remain perennially fertile

and would in fact greatly increase in productiveness from the manure accumulations. With no crops but the corn and cow peas these lands could never be worn out if the products are fed on the place as they should be. The use of the manure would greatly increase the natural hay crop of crab grass, which will render the peas more readily cured. On a swamp land farm we would never think of selling the crops in any shape but as beef and pork.

THE SANDY LANDS OF THE COAST REGION.

We have to some extent referred to the treatment of these, but there is such a capability for a diversification of crops on these lands that we refer again to their treatment. Throughout all the esatern part of the state the wide areas of flat sandy soil underlaid by a compact clay subsoil offer the best possible opportunity for easy and successful improvement. These lands are naturally more deficient in the mineral elements, such as potash and phosphoric acid, than the red clay uplands, and hence in the start of their improvement there is greater need for the application of fertilizers than in the upland country, where the mere improvement in the mechanical proparation of the soil will do far more. There are few of these Eastern sandy soils where there is any need for the subsoiling we have advised for the upland country. Where the clay is near the surface or where there are local sections of clayey soil such as one finds between Trenton and Pollocksville in Jones county, and to some extent in other eastern sections, the same treatment as to deep plowing and subsoiling is advisable, provided the soil is either naturally or artificially well drained. Subsoiling is of no use whatever in a water-soaked soil, for it soon returns to its former condition. But where the land is clayey in its nature and well drained, the subsoiling will be of advantage. There are also soils that should never have the subsoil turned up. The sterile subsoil of a pipe clay soil in its undrained state is always such that the turning of it to the air will make the soil worse instead of better. These pipe clay soils are really composed of more sand than clay, but the sand is so fine as to be quicksand when wet, and has clay enough in it to make the hardest kind of clods when dry. It is a soil that is naturally sterile, and the only thing that can be done for its mechanical improvement is by underdraining and liming. When well underdrained, the soil may be deepened by subsoiling, but the plowing on such land with a turning plow should never be anything but shallow. But it is mainly of the treatment of the wide areas of sandy lands with a clay subsoil that we would here treat. Much of the area of these lands has been so reduced in fertility by the constant cultivation in cotton that any start in their improvement must begin with an application of plant food. On

these lands is the paradise of the cow pea, and in no section of the state can greater results be had from the growing of the pea than on the sandy coast plain lands. They are the easiest of all lands in the state to improve and the quickest to run down by bad treatment. Hence the need of constant systematic farming to conserve the fertility and to keep it advancing instead of running down. The great temptation to the farmers of that section of the state is to get hold of a fresh piece of land and run it in cotton till it fails to yield a good crop, while by proper treatment the lands can be kept up and constantly increasing in productiveness. The eastern section of North Carolina is not a wheat growing section. Soil and climate are both against, and while we fully believe in growing a diversity of crops we do not believe that a farmer should grow a little of everything. While one-crop farming has run the lands down and should be abandoned, there is no reason why the cotton farmers of Eastern North Carolina should not make a specialty of cotton. There is a great difference between a specialty and a single crop. In farming with a specialty, we so arrange the rotation that the growing of the other crops tends towards the greater production of the specialty in the most economical manner. In the nature of things cotton will always be the leading money crop of this section even where tobacco has come in for a share of attention, for there is no need for the one interfering with the other since the tobacco crop can usually be gotten out of the way before the cotton picking begins. We have long been of the opinion that the man who inaugurates the culture of cigar tobacco in Eastern North Carolina will do more for himself and his section than by trying to grow the same kinds that are so successfully grown in the northern part of the state. But to take up the idea of the improvement of the sandy eastern lands. We have said that this is the paradise of the cow pea. Clover is out of the question. It can not be depended upon and it is well that it can not, for the cow pea in these lands will do far more than clover will anywhere, and no one in Eastern North Carolina should waste time in experimenting with red clover, or for that matter with any of the clovers. After the land has been brought up and the mineral matters plenty in it, the annual crimson clover may easily be grown as a winter crop in preparation for the corn crop. Many attempts have been made to grow this crimson clover in Eastern North Carolina but they have generally failed because the soil is not in condition to grow it. But when the soil is brought up in fertility it can be successfully grown. I saw an instance of this in the flat, sandy soil about Darlington, S. C. There the crimson clover is generally a failure as in the sandy plain country generally. But near Darlington a livery stable man in the town had some lots just outside where he hauls his stable manure and grows therewith some wonderful crops of all kinds.

On one piece of land he sowed crimson clover and made a wonderful crop and showed that the reason for the failure of the others was the poverty of the soil. Red clover and all the perennial clovers that grow through the whole year can never be a success on the sandy soils of Eastern North Carolina, but when once the soil is gotten into a fertile state the annual crimson clover, which grows through the cool season only, can be grown with perfect success and can be made a valuable adjunct to the cow pea.

Starting, then, with a piece of sandy land only capable of making a meagre crop of corn, we would not run its fertility down further by the growing of a hoed crop even with the aid of fertilizers. We would start at once with the cow pea. Give the land a dressing of acid phosphate and potash mixed in the proportion of four or five parts of acid phosphate to one of the muriate of potash, and use of this 300 lbs. per acre. This will give a fairly good growth on the thinnest soil. If the object is the rapid improvement of the land at once, without regard to the most economical method, then let the crop die on the land and remain till time to prepare it for the cotton crop. At this stage we would use another dressing of the same mixture under the cotton. The dead peas will give all the nitrogen needed, and in addition the seed of last year's cotton can be buried down the middles as before suggested so that the plants will find them at fruiting time. At picking time or just before finishing it sow rye all among the cotton to prevent the wasting of fertility in the winter rains. After a while crimson clover can be used for this purpose, but at first it is more certain to use the rye, as it will grow and make a soil cover though not near as valuable as the clover. Now, during the winter get out all the manure you can get hold of and all the black earth you can rake from the woods and try to cover the field all over with something. Prepare it in spring for corn. Do not waste commercial fertilizers on the corn, for you can not make it pay to do so. Plant the corn early so that you can have it ripe enough to cut down during the dry weather of the early fall. Cut it off at the ground after the August rains are over, and cure it in the shock. In September harrow the land wth a disc and make the surface fine and sow the Virginia turf oats at rate of three bushels per acre. It may be well at first to give these a little of the mixture of acid phosphate and potash, but in any event, after the oats are cut give the same dressing for the peas that are to follow. Then repeat the rotation, but by this time it will be best to cut the peas and cure them for feed and get more stock to eat them up, and save the manure to go on next year's corn. By the time you have been twice around in this three year rotation, and have dressed the corn field twice with manure and woods earth you will find that the only place you need to use anyfertilizer at all is on the oats stubble that is to go in peas.

There is the place where the fertilizer will tend to the building up of the soil most. You will never need to buy an ounce of nitrogen or ammonia, for the peas once in three years will give you all you need when aided on the cotton by the seed of the year before. Of course if you can get near by a fair exchange of meal and hulls for the seed it may pay you to make the exchange, but if this is not the case then use the seed and put them—not under the cotton to interfere with the stand—but in the middles where the wide reaching roots will find them as soon as they are rotted and will find them just when they need them most. The keynote to all this is the keeping the land at all times covered, espcially in winter to prevent washing from rains, and the putting of homemade manures just where they will do the most good to the intermediate crops, and the commercial fertilizer where it will produce the best results in the getting of feed to make manure and in fixing nitrogen in the soil for the cotton crop that follows. When you get your land up to this point, you will be less anxious about the price of cotton, as you will know that you are not obliged to sell it to pay a fertilizer bill. Then from the feeding of the corn and forage grown you should be able to get cash that will enable you to carry on farming on a cash basis, and be rid of the great drain that long credit makes on a man's pocket, for with the cash you can be getting instead of paying interest.

After you have followed this rotation for a while and find that instead of a fourth of a bale of cotton you have gotten a bale or more, do not be tempted to break up the improvement and put a field in cotton a second year simply because it made a big crop last year, but persevere till every field on the farm will make the highest yield. Then, too, do not argue that as all your land will make a bale per acre it will not pay you to grow corn that does not pay as much cash as cotton. You need the corn and the oats to keep up the land, for as we have said while that level sandy soil quickly responds to improvement, it quickly reverts if badly treated. If you grow the other crops you will soon become interested in the stock raising and feeding, and will find farming with cotton something far beyond the mere cropping it has always been to you. With some such system of cropping and stock feeding Eastern North Carolina would soon become a veritable Egypt in productiveness, and plenty will reign over her broad acres and population will flow in where good farming is done.

CARE OF THE HOMEMADE MANURE.

The growing of plentiful supplies of pea-vine hay and the making of ensilage from the corn and pea vines will give a new value to the manure made, for it is a well-known fact that the value of

the manure depends on the quality of the food consumed. Cattle that are starved through the winter on corn shucks and straw make manure that is worth little more than the rotted stuff from the forest if as much. Cattle fed on a rich and well combined ration not only thrive on it, but their droppings return the quality of the food fed. Hence a single load of manure from highly fed cattle is worth many loads of that from cattle that have had a poorly balanced ration or have had just enough of something to keep them alive through the winter. These facts of themselves are sufficient to induce a better feeding of domestic animals. But it is not enough to make rich manure by good feeding. It must be handled so as to preserve its value for the nitrogen in the manure leaves us very rapidly under certain conditions. If thrown out under the eaves where the rain falls on it, the soluble portion, that is the most valuable for plants, soon washes away. If thrown out in piles it soon heats and the ammonia is changed into a carbonate and flies off in the air as we can ascertain by our nose. The pungent odor of a heating manure pile is the nitrogen getting away in the form of ammonium carbonate. That nitrogen has cost you money, and if you have to buy it in a fertilizer you will have to pay about 15 cents per pound for all that you are allowing to waste in the air. The best place for manure is out on the field where some plant can get the use of it. If you are farming in the rotation described you will have during the winter either rye or crimson clover growing after cotton, and to be put in corn. Then as fast as the manure is made do not throw it out to "waste its sweetness on the desert air," but get it at once out and spread it on the land that is to go into corn the next spring. There it will increase the clover or rye growth and be in condition to do more for the corn. It may dry some when spread on the surface, but it will not lose the ammonia to any appreciable extent. If for any reason this course is not practicable the next best thing is to allow the manure to accumulate in the stable, and to be kept trodden under foot of the animals, using, of course, plenty of bedding to absorb the urine. Kept in this way there will be no violent heating and the manure will not be washed away. I visited a prosperous farmer on the sandy soils of Eastern South Carolina some years ago in August. He was stall-feeding beef animals summer and winter, and selling them as the butchers wanted them. At the time of my visit I found him cleaning out the accumulated manure from the stables and spreading it between the rows of cotton on a field that promised a full bale per acre. I asked him if he thought the fresh manure could be of any great value to the cotton on a field that promised a full bale per acre. I asked him if he thought the fresh manure could be of any great value to the cotton at that stage of its growth, for the first bolls were then about opening. He replied that he was not putting it there for the cotton,

though he thought that it would do that no harm, but he intended to sow that cotton in crimson clover to grow the next winter in preparation for his corn crop, and knew that the manure on top the ground would make this more certain, and that he would save what he would have lost had he piled the manure in the yard. I then no longer wondered that this man had built a handsome residence and was living the life of a country gentleman on a soil naturally as poor as any of our piney woods land. He was using brains in his farming. This is the great necessity after all—the use of brains and thought in one's work. It is impossible for me to give plans here that will fully meet the conditions of each. I can but suggest plans. The thoughtful farmer must use his own brains in adapting any advice to his work.

TRUCKING AS AN ADJUNCT TO GENERAL FARMING.

So far we have said nothing about the trucking of the eastern section. There is a tendency among the farmers of Eastern North Carolina to mix a little truck growing with their farming. As a rule we believe that this is a great mistake. The men who are doing this are those whose inferior products glut the market at times and render worthless the crops of the real gardeners. Trucking is a business of itself, and can not be well carried on by a farmer engaged in general cropping. A man should be a farmer all the way through or a gardener and nothing else. Still while the general trucking for the Northern markets should be left to the men who have invested capital and labor in it as a business, and can not be as a rule made profitable when used as a side issue, there is a certain kind of trucking that nearly every farmer can do and should do. This is the growing of such things as are in demand in his local market, and which can be used through the year as a source of family cash. Few of the markets in our North Carolina towns are supplied with home grown vegetables and fruits. By far the larger quantity of these things sold in towns like Raleigh, Winston, Charlottte and Wilmington are brought over the railroads from North and West. If every farmer would make himself familiar with the cultivation of vegetables and would devote a piece of land to this purpose and give it the best attention, so that whenever he is compelled to go to town he can carry along a load that will buy what he wants, and will keep him in cash during the summer, it would be found one of the most profitable additions to the general farming of the state. The great increase of the cotton mills of the state, with their crowds of operatives that must be fed, opens up local markets in many sections remote from the large towns and the thoughtful farmer will take advantage of these things.

PASTURE.

The keeping of live stock necessitates pasture for them in summer. Land is too cheap here for the soiling of cattle in summer on cut green food to be made profitable. But when a man has the greater part of his land in a three- or four-year rotation either as a grain or cotton farm, and lives in a "no-fence" district, he can not graze his cropping land, and does not wish to. The question of a permanent enclosed pasture then becomes of prime importance. And that such a pasture can be made in all parts of the state we know full well, if the proper grasses are used and they are properly treated and cared for. In the upper districts this is a far easier matter than in the coast country, but even there there are grasses that will make a permanent sod. The pasture must be near the farm buildings as a matter of convenience and the soil should be well prepared before seeding. In all the upper red clay country the main reliance should be in orchard grass for a permanent pasture, but in all sections there will finally be a mixture of the native grasses in any pasture. For a permanent pasture the seeding must be heavy, for the sod should be quickly and thickly made if any success is desired. In the upland section we do not know of any better mixture of grasses than orchard grass, red top and Virginia blue grass *(Poa Compressa)*. One bushel (14 lbs.) of each will be the quantity to sow per acre. Do not sow any white clover, as you will have plenty of it any way, and it is not desirable where horses are to be pastured, as it slobbers them too much. Make the sowing in September or October, and harrow the seed in with a smoothing harrow. Do not pasture it till late the following summer and then but little. Better give the grass a chance to seed and thus increase the density of the sod.

When we come to the level lands of the east we have different conditions. Here the grasses named do not as a rule succeed so well. But there is one grass that is hated by the cotton farmer, but which is of all others the best pasture grass for the east. This is the Bermuda grass. There is no danger that it will get into the cotton fields if care is used, as it does not make seed here, and can not thus get into the manure. It can easily be kept in bounds and as a summer grass for pasture it has no superior. But it is a summer grass only and hence needs some mixture to make a winter pasture. This can be found in the Texas blue grass, a grass that has a creeping stem like the Bermuda and can be grown in the same manner. This is a winter grass entirely and seldom makes any show in hot weather. The way to get a sod of these grasses is to get the creeping stems, commonly but erroneously called roots. Run these through a feed cutter and then mark out shallow furrows about two feet apart over the land, scatter the cut stems in these, cover and

roll. This can be done in spring or fall, but for the Bermuda is best in spring. By the end of summer the grasses will have taken possession of the whole land and the density of the sod will increase from year to year as the creeping stems run to and fro. We have seen such a sod on the sandy pine lands of South Carolina that was as dense and springy as the best blue grass in Kentucky, and the fine stock kept on the place attested by their looks the value of the feed. While the Bermuda grass should never be allowed in the upper red clay lands where other grases can be grown, there is no better grass for pasture where it is at home in the eastern section.

HOGS FOR NORTH CAROLINA.

Experience has long ago demonstrated that no white hog can be a success in the South. The black razor back of the piney woods is the survival of the fittest, for the white hogs soon succumb here to the effects of mange and sun scald. There are a number of the black breeds that have been tried in the South with varying success. The Essex is preferred by some who take especial pains with their hogs and do not expect them to hustle for themselves in the woods. But many consider them too small in size and too delicate in constitution. The Poland China has become the popular hog over a large part of the country, particularly in the West. The chief objections urged against them are that they are not as prolific as other breeds, and that they make a larger quantity of woolly hair that makes them harder to clean. In my own experience I have found the Berkshire to more nearly fill the bill than any other breed. Where hogs are allowed a woodland range the Berkshire is as good a hustler as the native razor back, and this is true of them to a greater extent than any of the improved breeds. Then, too, as the hams are the most valuable part of a hog's carcass, there is no breed that makes as round and well-shaped hams as the Berkshire. In the hands of one intelligent farmer of South Carolina I found several years ago a stock of pigs raised from crossing a Berkshire on the sows of the Essex breed. These seemed to me to be the ideal pig for the South, having all the delicacy of bone and small offal of the Essex, with the hardy and prolific character of the Berkshire. But whatever breed is kept it should be one that will fatten at any age, for there is no profit in a hog that has to be wintered over before killing. No hogs should be kept over winter except the breeding stock, except in the case of fall litters to be fattened and killed in the early spring. When an improved breed is kept pure there will always be demand enough for breeders to take up the fall litters in the spring. The best time in the South to have the pigs come is in March. Then vegetation begins

and soon there is grass to turn them on if one keeps a permanent pasture. The cows are then giving a full flow of milk, and skim milk can be had for the pigs. If kept growing during the summer on green food of any kind and turned on a pea field as soon as it is ready for them, the pigs can be kept growing and can be sold off to the butchers alive at six months old, or can be kept till December and slaughtered for bacon, after a proper feeding of corn in the fall. At the Alabama station it was found that a field of peas fed off when ripe by hogs gave a profit of $10.50 per acre, and the land was enriched by the trampled pea vines and the droppings of the animals. In many sections this may be the best use for the pea, though in most places the larger part of the pea crop will be more profitably harvested as hay for the feeding of stock. But on all our farms it will pay to have a lot of peas in which the hogs can feed and fatten till corn time. In the upper clay country, where clover will thrive, the place for the hogs in the early part of the season, till the peas are ready, is in a blooming field of clover, with noses jewelled to prevent rooting. Here they will thrive well till the earliest peas are ripe and after that with a succession of peas the hogs can be kpt growing and fattening till corn comes in and the finishing time in the pens is at hand. This method of breeding and treating will be found far more profitable than the ranging of the woodlands. Of course hogs kept in this way will need attention as to having a supply of clean water, shade from the sun, and an occasional dose of salt and wood ashes and cinders. They will be far less liable to cholera than those allowed to run and come in contact with other animals. If all dead animals were promptly buried out of reach of dogs and buzzards it would be far easier to keep clear of cholera than it is now. The worst attack we ever had of hog cholera was brought to us by buzzards which attacked a hide that I was trying to cure on the side of my hog house. This taught me a lesson I have never forgotten, and I have ever since kept out of the way everything that can attract the buzzards, which are the great carriers of the hog plague. If you keep rid of buzzards, prevent contact of your hogs with others, and feed them during the warm weather with green succulent food, and no corn till cool weather and fattening time you will hardly ever be plagued with the cholera, particularly if they do not come in contact with streams of water that may bring infection from dead animals carelessly thrown into it above. See that the water they have is pure and uncontaminated, and the food is all right and you need have little fear of the cholera.

HAMS AND BACON.

We have said that the selling of raw products will never be as profitable as the turning of them into a more costly form. The live

hogs are to some extent a manufactured product of the peas, clover and corn, and they make a better use of these than the selling of the raw products would. But the manufacturing idea may profitably be further extended in the case of the hog, and the cured product will bring more money than the animal on the hoof. The great success that has attended the home curing of hams and bacon in the southeastern counties of Virginia shows what can be done with the hog on the farm. The great mass of the hams, so called, sold on the market, are the product of the great packing houses in the West. To one who knows a well cured ham these so-called hams are an abomination. The hams freshly slaughtered are injected with brine and saltpetre, and then run through a vat of a sort of creosote solution and at once placed on the market as smoked hams, when they have never been properly cured nor smoked. One who has been accustomed to well cured hams and well smoked ones does not wish to taste any of this meat at all after he has once tried it. The Smithfield hams of Virginia have gotten their reputation from the fact that they are cured in the old-fashioned way, and are really well smoked with hard wood smoke. In no other way can a well cured ham be made. Some of our North Carolina farmers have of late years gotten into the notion that smoking is no longer needed, but that a ham properly cured and then hung up and dried is all that is needed. But whatever the individual taste may be in this matter, the market demands a well smoked ham, and there is no doubt that the smoking gives the proper flavor that people like in a ham. When one is making a product for the market he must make what the market demands if he wants to get the best price. Go into the grocery stores in Raleigh to-day, and you will find the so-called sugar-cured hams of the packers, the well smoked hams of the southeast Virginia country, and the white dried hams of the surrounding farmers. Of the three, the highest price by far is asked and received for the Virginia hams, and the lowest price for the North Carolina hams. There is no reason whatever that the North Carolina hams should not command as high a price as the Virginia hams except that they are not treated as the market demands. The Virginia curer knows that the market wants just such a ham as he has always been making, and he makes no experiments with dried or unsmoked hams. With Smithfield hams selling for double the price of those of the packers and those of the North Carolina ham dryers, it should teach our people what is the profitable course for them. They may like the white dried hams, but the city buyers do not want them and they are sold at a lower price in consequence of the neglect of the packers to put them in shape for the market. Some years ago I was at the residence of a large and successful farmer in an adjoining state. He lived in the flat, sandy, piney wood section, yet he kept improved stock of all kinds, and

made a profit from them while getting his acres up to the average of over a bale of cotton per acre. Sitting on his porch one evening I saw a wagon drive up from a grocer in the neighboring town and it was soon loaded with well smoked hams and sides. The owner told me that the bacon cost him per pound just what his cotton cost, and he got for the cured bacon fully three times the cost and for the hams nearly four times, and that to the extent it could be carried on his farm, the curing of hams and bacon was far more profitable than cotton growing, but said he, "All go together to make up the product of a farm, and to keep me on a cash basis." There was the true secret of success, to have something at all seasons of the year to bring cash, and to prevent the heavy interest that the credit man has to pay on what to him are only "supplies" but to the other are a source of no small income. So long as our people look upon all other crops outside their money crop simply as "supplies" and never expect to make profit out of them through systematic farming, just so long will the cotton growers be at the mercy of the money lender and the fertilizer mixer. If anything we have written here will aid them in getting out of this slavery we will be abundantly rewarded for our work.

HOW TO CURE HAMS AND BACON.

There are two methods of curing on the farm—dry salting and pickling. Dry salting is more largely practiced than pickling, but in our experience we have been led to prefer the pickling. We prepare a brine strong enough to float a potato, and after the meat is cut and trimmed it is dropped into this brine for two or three days to draw out the blood. It is then taken out and a fresh brine is made, or the old brine boiled and skimmed. To the brine we then add one ounce of saltpetre and a pint of black molasses for each 100 pounds of meat. The meat is then returned to the brine, the thinner parts being put to themselves and the hams and shoulders in another cask. The thin parts remain in the brine three weeks and the hams four or five weeks, care being taken to keep all under the brine. The meat is then taken out and hung in the smoke house or elsewhere to drip and dry somewhat. It is then slowly smoked with corn cobs or hickory wood, the smoke being smothered down with green cedar branches if they are to be had. The smoking is continued for several weeks in favorable cloudy weather, until all are well smoked. The hams should have the upper part of the smoke house, where the smoke hangs longest. In the early spring the hams are taken down and rubbed well all over with a mixture of molasses and black pepper. They are then wrapped in stout paper and put into cotton bags, which are dipped in whitewash, and are again hung up. Some pack them down in chaff, but we prefer

to keep them hanging. They are at their best for the table or market at a year old, and one who tastes a year-old or older ham cured in this way never wants to taste the "embalmed hams" of the Western packers again as long as he lives. Hams of this kind will bring 18 to 20 cents per pound when the hams of the West and the white hams of our farmers are selling for ten cents per pound.

IMPROVING THE CORN CROP.

Corn is the staple crop for the fattening of hogs and other animals, and the increasing of its productiveness is a matter that should interest every farmer. We have already told how we would use the crop in a rotation, but there is another point on which there is great need for information. This is the proper saving and improving the seed. Farmers write to the station from all over the state, asking our opinion of the value of the various new kinds of corn offered by seedsmen. They never seem to realize that it is in the power of every farmer to so improve the corn he grows that it will always be the best he can get for his planting. Corn, more than most of our farm crops, needs to be developed in the climate where it is to be planted. Corn brought from far North or far South will never do as well here until it gets acclimated as the corn we already have. Every fall, at the State Fair and at the county fairs, one sees magnificent ears of corn shown, and people try to get some of it to carry home. We have learned long ago that these extra large ears have grown on single-eared stalks and a long ways up from the ground, and that to get a greater productiveness we do not want these great ears. When one starts out to improve the character of his seed corn, he should not look to a single feature but to the general character of the plant. Our Southern corn from the careless manner in which the seed has been selected, has been getting further and further from the ground to the ears, and has developed the habit of making a single big ear, and a great many barren stalks. A year ago we were travelling in the beautiful valley of the upper Yadkin and passed a field of corn that at first sight seemed marvellous in its growth. But a close inspection showed that in this mass of foliage and stalks there were almost as many stalks with no ears as there were with ears, and those that had ears had but a single one. This is the result of a careless selection of seed. The barren stalks have the tassel, the male organ well developed, and they are spreading their pollen all around to infest the others, and seed saved from that field, while it may show magnificent ears, will be worse than worthless. When one starts to get an improved strain of corn he should select the best kind that he can find in the neighborhood. Plant a piece especially for seed. When the tassels first begin to show, and before they have ripened pollen,

go through and cut the tassels from every stalk that does not show silks, and so prevent these barren males from affecting the crop. Then, when the crop is ripe, go through again and take the lower ear from a stalk that has two or more, and never take one from a single-eared stalk. You will find that these lower ears are not as fine looking as the upper ones, but we are after getting the hereditary tendency of making an ear above the one selected. We could easily select the best looking ears in the crib, and that is what has ruined the corn, and given it a tendency to make but one ear and that higher and higher from the ground. We want to cure this and get a twin-eared corn and one that has less stalk between the ear and the ground. So no matter if the lower ear is not so good looking as the upper one, take it for seed, and breed for the general character of plant rather than for a single feature as in the past.

Then next season plant your seed patch from this seed as well as your main crop, and continue in the seed patch the selection as before. After you have carried on this selection for a few years you will begin to see a great improvement in your corn. It will grow shorter and more sturdy, not so liable to blow down and will get into the habit of making two or more ears. Then in a few years of this careful selection and re-selection, you will find that your neighbors who will not take these pains will be taking an interest in your corn, and you can sell it for seed to advantage. Another result of a better character of plant will be the fact that you can grow the corn nearer in the row and the rows nearer than corn is now planted, and thus increase the product of your acres. There is hardly a farm in the piedmont section where the corn crop by good farming and good selection of seed could not be raised to at least 50 bushels of corn per acre or even more. When we get our corn to 50 bushels per acre and the wheat and oats to a proportional yield, we will find that what we have been looking at simply as "supplies" have reached a point of profit.

It is towards this that the Experiment Station is working. The station was established to help the farmer, and in the present state of agriculture in this state we know of no way in which we can help him more than by disseminating information on the topics that interest him, and by always being ready to answer letters from the farmers on everything on which they feel that they need information. In this bulletin we have endeavored to give hints that acted upon can not fail to advance the welfare of the toilers on the farms, and if anything we have written aids in the elevation of the work of the farmer to a higher plane and a more profitable use of the soil and its products we will feel that we have done a good work.

RECENT BULLETINS.

The following are some of the recent Bulletins of the Experiment Station:

No. 100. Our Common Insects, cuts 65, pp. 36.
No. 101. The Progress of the Dairy Industry in North Carolina, pp. 8.
No. 102. Encouragement to the Dairy Industry, pp. 12.
No. 103. Miscellaneous Agricultural Topics, pp. 24.
No. 104. Why Pull Your Corn Fodder? pp. 4.
No. 105. The Chestnut and its Weevil; Nut Culture, pp. 12.
No. 106. Rational Stock Feeding, pp. 44.
No. 107. Propagation of Flowering Bulbs in North Carolina, plates 24, pp. 24.
No. 108. Seed Testing; Its Uses and Methods, pp. 64.
No. 109. Feeding Trials With Animals, pp. 34.
No. 110. Marls and Phosphates of North Carolina, pp. 50.
No. 111. The Fertilizer Control During 1894, pp. 26.
No. 112. Trucking in the South, pp. 70.
No. 113. The Testing of Milk, cuts 4, pp. 32.
No. 114. Tests of Dairy Implements and Practices, cuts 4, pp. 32.
No. 115. Miscellaneous Agricultural Topics, pp. 20.
No. 116. Milk Records and Tests, pp. 16.
No. 117. Tuberculosis and its Prevention, pp. 20.
No. 118. Cotton Seed Hulls for Beef Production, 4 pages.
No. 119. Volumetric Estimation of Phosphoric Acid, 21 pages.
No. 120. Cultivation of the Peach Tree, 42 cuts, 31 pages.
No. 121. Hillside Terraces or Ditches, 8 cuts, 5 pages.
No. 122. Types of Tobacco and their Analyses. (Technical.) 35 pages.
No. 123. Miscellaneous Agricultural Topics, 10 pages.
No. 125. Forage Grasses and Hay Making, 44 cuts, 49 pages.
No. 128. Pests of Grain Crops, pp. 12.
No. 129. Horticultural Experiments at Southern Pines, 1895, pp. 46.
No. 130. Poultry Keeping for Profit, 39 cuts, 53 pages.
No. 132. The Home Vegetable Garden and its Pests, 8 cuts, 54 pages.
No. 133. Some New Forage Fibre and Other Useful Plants, 2 pages.
No. 136. Fertilizer Analyses of the Fertilizer Control, 34 pages.
No. 137. A Warning in Regard to Compost Peddlers, 8 pages.
No. 138. San Jose Scale in N. C., 1 cut, 14 pages.
No. 139. Home-mixed Fertilizers and Composts, 16 pages.
No. 140. Volumetic Estimation of Phosphoric Acid. (Technical.) 8 pages.
No. 141. A New Tobacco Pest, 2 cuts, 8 pages.
No. 142. Comfortable Low Cost Barns, 12 cuts, 20 pages.
No. 143. Feeding Experiments, Milk Records, etc., pp. 36.
No. 144. Ornithology of North Carolina, pp. 36.
No. 145. Crimson Clover, pp. 20.
No. 146. Miscellaneous Farm Bulletin, pp. 16.
No. 147. A Study of Lettuces, pp. 8.
No. 148. Digestion Experiments, pp. 32.
No. 149. The Apple in North Carolina, pp. 22.
No. 150. Medicinal Plants of North Carolina, pp. 84.
No. 151. The Fertilizer Control for 1897, pp. 12.
No. 152. Poultry Notes, pp. 24.
No. 153. Vinegar Adulteration, pp. 8.
No. 154. The Adulteration of Coffee and Tea, pp. 16.
No. 155. Baking Powders on Sale in North Carolina, pp. 8.
No. 156. The Adulteration of Flour, pp. 12.
No. 157. Mineraline, pp. 8.
No. 158. The Fertilizer Control for 1898, pp. 16.
No. 159. Horticultural Experiments at Southern Pines, 1896, pp. 92.
No. 160. Digestion Experiments, pp. 20.
No. 161. Drinking Water, pp. 20.
No. 162. Farming in North Carolina, pp. 34.

Any of the above will be sent cheerfully upon application by postal card to the Director of the North Carolina Agricultural Experiment Station, Raleigh, N. C.

BULLETIN No. 163 MAY 10, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR.

Rational Stock Feeding

INCLUDING

I. Definitions of Terms, and Composition and Digestibility of Foods

II. Feeding Standard

III. How Stock Rations can be Calculated

F. E. EMERY AND J. M. JOHNSON

RALEIGH, N. C.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E. EMERY, M.S., Agriculturist.*
W. F. MASSEY, C.E., Horticulturist.*
COOPER CURTICE, D.V.S., M.D. (1) Veterinarian.*
G. S. FRAPS, B.S. (2) Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES, Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist.
J. M. JOHNSON, M.S., Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B.E., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M., State Chemist.
C. B. WILLIAMS, M.S., Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY, Assistant Chemist.
W. G. HAYWOOD, B.LITT, Assistant Chemist.
H. E. KING, Chief Clerk.
MISS M. S. BIRDSONG, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them. *Samples for analysis should be sent to the State Chemist.*

---

* Member of Station Council.
(1) On leave of absence.
(2) On leave of absence. The duties are performed temporarily by J. M. Pickel, Ph.D.

RATIONAL STOCK-FEEDING.

INCLUDING

I. DEFINITIONS OF TERMS, AND COMPOSITION AND DIGESTIBILTY OF FOODS.
II. FEEDING STANDARDS.
III. HOW STOCK RATIONS CAN BE CALCULATED.

By F. E. EMERY, M. S., Agriculturist. J. M. JOHNSON, M. S., Ass't in Agriculture.

I. DEFINITIONS OF TERMS, AND COMPOSITION AND DIGESTIBILITY OF FOODS.

The value of food materials depend largely upon their composition and digestibility. The former is ascertained by chemical analysis; the latter by actual trials with animals.

Composition of Feeding-Stuffs. Nutrients.

By chemical analysis, foods are separated into six classes of substances, viz.:

1. *Water*, which is present in all feeding-stuffs. It composes about 80 per cent. of green and succulent fodders, about 90 per cent. of root crops, 75 per cent. of silage, and 10 to 15 per cent. of hays and grains. In these it is present as mechanically adhering or hydroscopic moisture. It is a necessary constituent of the animal body, of which it makes up 40 to 65 per cent. Water is determined by heating the substance for several hours at the temperature of boiling water, at which temperature it passes off as steam.

2. *Ash* is the inorganic, or mineral matter of plants, and is the residue left after burning till all volatile material is driven off. It is composed mainly of soda, potash, lime, and magnesia, in the form of phosphates, sulphates, chlorides, and carbonates. Ash furnishes the materials for the bony structure of animals, and enters to a much less extent into the tissues and organs.

3. *Fats* (*ether extract*) represents whatever is dissolved from foods by dry ether. It is composed mainly of fats and oils, but contains, in addition, quantities of gums, wax and coloring matter, depending upon the substances extracted.

4. *Protein*, the term as used in connection with fodder analyses, includes *Albuminoids* and *Amides*, the albuminoids being the more

---

Note.—This bulletin is a revision of No. 106, with many additions to the tables which increases the usefulness of the work to the practical feeder.

valuable, and, at the same time, composing by far the larger portion of the protein compounds. They are the nitrogenous compounds of plants and animals, and are determined by estimating the nitrogen in them, which element composes about 16 per cent. of the weight of protein substances. None of the other classes of substances contain nitrogen. They are represented in the animal body by ligaments, lean meat, muscles, tendons and tissues. *Amides* are unorganized protein, or protein in a transitory stage, and are very abundant in pasture grass and young growing plants, but change largely into organized protein as the plant reaches maturity. Amides are considered of much less nutritive value than albuminoids, and act as protectors or conservers of the latter.

5. *Crude fiber*, or *cellulose*, is the cell wall and structure material of plants, and is usually the most indigestible portion of them, but when digested is considered of equal value to starch and sugar. The lint of cotton is almost pure cellulose. Its composition is similar to that of starch. It is determined by boiling the food-stuff with weak acid and alkali, thus dissolving all other constituents. *Crude fiber* and *nitrogen-free extract* taken together are known as *carbohydrates.*

6. *Nitrogen-free extract* is the term applied to those non-nitrogenous constituents of foods which are represented in the main by sugars, starch, dextrin, and gums. They all contain carbon, hydrogen, and oxygen, but no nitrogen, as does protein. Nitrogen-free extract is estimated by difference, it being equal to the difference between the sum of the above five constituents, water, ash, protein, fats, and crude fiber, and 100. It is, perhaps, the most inaccurate of all the determinations in a food analysis, inasmuch as all the errors and differences in the other determinations fall upon it. It seems very desirable that some of the constituents, at least, of the nitrogen-free extract should be determined directly. This is already being done to a limited extent. Some preliminary work has been done in this laboratory in that line, and the study will be carried on.

Dry matter and organic matter. Neither of these terms represent a single class of constituents, or nutrients. Dry matter is what is left of a plant, or food stuff, after the water is driven off or subtracted, and organic matter is dry matter minus the ash, for example: If the original food-stuff as fed is represented as 100 per cent., and it contains 10 per cent. of water and 5 per cent. of ash, then dry matter is equal to 100 per cent., less ten per cent. water, or 90 per cent., and organic matter is 90 per cent. dry matter less 5 per cent. ash, or 85 per cent.

To enable those not familiar with the subject to gain a clear idea of the parts of food-stuffs, and the terms representing them as used in fodder analyses, the following statement is presented:

Food-stuff.	Water.			
	Dry matter.	Ash.		
		Organic matter.	Protein.	
			Fats.	
			Carbohydrates.	Nitrog'n-free ex't.
				Crude fiber.

Nutrients. Protein, fats, carbohydrates, nitrogen-free extract and crude fiber and mineral matter are called nutrients, because of their functions in animal nutrition. Nitrogen-free extract and crude fiber are included together under the one name of carbohydrates, because they are all compounds of carbon, hydrogen and oxygen, and the digestible portion of each is considered of equal value and perform the same offices in animal nutrition. Familiar examples of the four classes of nutrients are presented below. Water is omitted because it is the same, whether taken in food or drink, and we do not feed a fodder for the sake of the water it contains:

Protein.	Albumen (white of egg), washed lean meat, casein, or curd of milk, gluten of flour, fibrin of blood, gelatin, glue, etc.
Fats.	Cotton-seed oil, linseed oil, olive oil, corn oil, wheat oil, oat oil; the fat of milk (butter), the fat of meat (hog lard), mutton (mutton suet), beef (tallow), fish oil, etc.
Carbohydrates.	Sugars (cane sugar, milk sugar, and glucose), starch, dextrin, gums, woody fiber, etc.
Mineral matter.	Sodium chloride (common salt), phosphates of lime and soda, etc.

Functions of Nutrients.

Having defined the classes of nutrients as they occur in foods, it is of interest now to state the offices performed by them in animal nutrition.

Water is not a nutrient in the sense in which the term is here used, though the animal body can not be supported without it.

The ash, or mineral matter furnishes the material for the bony structure of the body, and, to a far less extent, of the soft tissues. Most of our foods and rations contain an abundant supply of the mineral element, so little or no notice need be taken of them in feeding.

Protein differs from all the other nutrients, in containing the element nitrogen, and is the producer of flesh, ligaments, muscles, tendons, sinews, hair, hide, and all portions of the animal machine which has strength, except the bones. The protein bodies are of the utmost importance in the animal structure. They compose the larger part of the animal machinery, and are the exclusive source of its repair as occasioned by the continuous wear and tear of the system, due to the internal and external movements of the body; they are the basis of blood, and the source of casein in milk; and in the absence of sufficient quantities of fats and carbohydrates in the food for the production of heat and energy, they are transformed into fats, and perform the office of fats in nutrition. This latter transformation may also result from an excess of protein. The heat-producing power of protein is but little different from that of

carbohydrates; the amount of fat it produces is probably much less, while as a heat-producer, fat is worth about 2.25 times as much as protein. These facts, combined with the high cost of protein in foods, renders it usually uneconomical to feed protein for the production of fat to be either stored in the body as such, or to be used as fuel, since the fats and carbohydrates perform these offices, and cost much less. It is to be remembered that the protein bodies are the "flesh formers," and though they can perform the offices of fats and carbohydrates in nutrition, fats and carbohydrates can not take the place of protein.

Fats and carbohydrates perform the same offices in the body—those of the production of heat to keep the body warm, and the force by which the animal mechanism is run. They are the "heat and force producers," and are consumed in the body as fuel, giving out heat, muscular, and intellectual energy. For the production of heat and energy one pound of fat is worth about 2.25 times as much as a pound of carbohydrates. Fats give out about 2.25 times the heat that carbohydrates do. Besides serving as heat and force producers, carbohydrates are converted in the animal body into fats, and, together with the fats of the food, are stored as such in fatty tissue. The value of carbohydrates for the production of fats is supposed to be in about the same proportion as the heat-producing powers of carbohydrates to fats.

Carbohydrates are not found in the animal body as such, but are converted into fats. There are, therefore, only four classes of substances composing the animal body, viz: water, ash, fats, and protein.

The main and distinctive offices of the nutrients of foods are: Ash, or mineral constituents, these are bone-producers; the protein bodies are the flesh-formers; and fats and carbohydrates are the heat and force producers. The nutrients already located in the animal body perform the same offices as the corresponding ones of foods. In case of a deficiency of nutrients in foods given, the fats, or protein and fats, are drawn upon to assist in running the animal machine. Carbohydrates and fats, in being consumed, prevent the consumption of protein, but so soon as they become insufficient to supply the necessary heat and force for the body, protein substances, in the form of lean meat, muscle, etc., are drawn upon. A sufficient supply of carbohydrates and fats is, therefore, necessary to the protection of the animal frame-work. The following is a statement of the

Functions of Food in the Animal Body.

Food nourishes and supports the body.

By supplying—

1. The materials of which it is made.
2. The materials to repair its waste and wear.

By producing—

3. Heat to keep it warm.
4. Force and energy for muscular and other work.

These offices are performed by the nutrients:

Protein	Which is the basis of blood, lean meat, tendons, ligaments, sinews, hair, skin, etc.— Is converted into fats. Is used as fuel for heat and force.
Fats	Are used as fuel for heat and force. Are stored in the fatty tissue of the body.
Carbohydrates (Nitrogen-free extract and crude fiber)	Are converted into fats and stored in the body, or Are used as fuel for heat and force.
Mineral matter	Forms bone and a very small part of muscular and fatty tissues.

The Digestibility of Feeding-Stuffs.

As was stated in the beginning, the value of feeding-stuffs depends upon their composition and digestibility. The element of composition has been discussed; next will be considered the digestibility.

All the food eaten by an animal is not digested and used in nutrition, but only that portion which is dissolved by the alimentary agents and taken into the circulation of the system, the portion which is assimilated. The residue, or undigested portion, forms the solid excrement of the animal.

The digestibility of a considerable number of American cattle foods have already been determined. This is done by feeding a uniform and weighed quantity of food of known composition for sufficient length of time to eliminate all residues of previously fed fodders, then collecting the dung for a number of days, usually five or six, weigh and analyze. The dung contains the undigested food residue, and the difference between this and the total food consumed gives the portion digested. Thus, two foods having the same composition, their values would be determined by the amounts of nutrients digested from each.

Average Composition and Digestible Nutrients in Feeding-Stuffs.

In Table V is presented the composition, most of them averages, of quite a number of analyses, of American feeding-stuffs of most interest in North Carolina. The composition, especially of coarse fodders, is affected by so many conditions, as soil, climate, season, cultivation, harvesting, handling, stage of maturity, etc., that the greater the number of good analyses entering into an average the nearer may the average be expected to represent the general composition.

The analyses of the feeding-stuffs shown in the table represent their composition as they are usually fed to animals. In addition

to the chemical composition of the foods obtained by analysis, is presented, also, the percentages of digestible nutrients in each, calculated from the percentage composition of the foods in the table by multiplying by the *coefficients of digestibility* of each food and nutrient contained in Table IV, which follows.

Coefficients of Digestibility.

The proportions of the different nutrients digested are obtained by dividing the total amount of each nutrient consumed by the amount digested. In Table IV are brought together the coefficients of digestibility of all the fodders, the compositions of which are presented in Table V. These are mainly the results of American experiments.

Amount of Digestible Matter in Feeding Stuffs.

In Table V is given the average composition of foods, and in Table IV their digestibility. By combining the data of these two tables the per cents. of digestible matter of the same foods, also shown in Table V, are obtained in the following way:

	Cowpea-vine hay contains per cent., or pounds in 100 of (see Table V).		Coefficients of digestibility of cowpea-vine hay (see Table IV).		Per cent., or lbs of digestible matter in 100 of cowpea-vine. hay.
Dry matter	88.10	×	59.2	=	52.15
Protein	14.43	×	64.5	=	9.31
Fats	2.49	×	50.0	=	1.24
Nitrogen-free extract	41.22	×	70.7	=	29.14
Crude fiber	21 54	×	42.9	=	9.24
Ash	8.42	×	45.1	=	3.79

They may be regarded as representing, as well as per cent., the number of pounds of digestible nutrients in 100 pounds of the various foods in the condition in which they are fed, and are the amounts of these foods used by animals in the support of their bodies.

From this table of percentage of digestible matter in foods, it is easy to ascertain the amounts of digestible nutrients eaten per day by the animals we may be feeding. We only need to multiply the number of pounds of the food or foods eaten by the per cent. of digestible nutrients in them. Say a cow is eating 20 pounds cowpea-vine hay per day, then the amounts of digestible nutrients consumed are found as follows:

	Per cent. of digestible matter in cowpea vine hay.		No. lbs hay eaten.		Lbs of digestible matter eaten.
Dry matter	52.15	×	20	=	10.43
Protein	9 31	×	20	=	1 86
Fats	1 24	×	20	=	.25
Nitrogen free extract	29 14	×	20	=	5.82
Crude fiber	9 24	×	20	=	1.85
Ash	3 79	×	20	=	.76

The amount of digestible matter eaten by any animal may be obtained in a similar way. Where two foods are fed in a ration each will have to be operated upon separately, and their sums taken for the total digestible nutrients consumed.

To save the feeder the time and trouble of making these calculations, the amounts of digestible dry matter and nutrients in 1, 2, 3, 4, 5, 10, and 2,000 pounds of the coarse fodders, grains, seeds, and by-products, whose composition and digestibility are presented in Tables V and IV, have been carefully calculated, and are given in Table III. The nitrogen-free extract and crude fiber have been combined in this table under the one name of carbohydrates, because the digestible portion of each is considered of equal value, and they perform the same offices in animal nutrition. The ash is also omitted, for the reason given in the first part of this bulletin. This table must not be supposed to give the absolute amounts of digestible nutrients contained in all the qualities of these various foods, for no two of the same kind are likely to have exactly the same composition, and may differ very widely, nor are any two animals, even of the same kind, likely to possess the same digestive capacity and power of assimilating foods. Even with these unavoidable defects the knowledge thus ascertained can be put to practical use, and, in connection with the Feeding Standards, soon to be described, stock can be fed far more intelligently, safely, and economically.

The digestible nutrients have been calculated for the most convenient numbers only, but by combining these and adding the corresponding nutrients, the amounts of digestible nutrients can be easily obtained for any quantity of food that is likely to be fed under ordinary circumstances. Thus, suppose we desire to know the pounds of nutrients in 15 pounds of any of the foods, we have merely to add the nutrients corresponding to the 10 and 5 pound weights; for 19 add those for 10, 5, and 4, and so on for any number up to 20, which may be obtained by moving the decimal point two places to the left in the line for 2,000 pounds. For numbers larger than 20, multiples may be used, as for 40 take four times the nutrients for 10.

The nutrients in 2,000 pounds of each of the foods were inserted in this table to enable comparison of the digestible nutrients in one ton of the different foods. The chief value of Table III will be found in the compounding of rations, and it will receive further consideration under that head.

II. FEEDING STANDARDS.

The composition and digestibility of feeding stuffs have been considered, and in the following tables the amounts of digestible nutrients in different quantites of foods will be presented. The next question asked by the interested feeder is, how much and in what proportion should the digestible nutrients be fed to different animals

for different purposes? This is a very difficult question to answer with accuracy. The results of a great many years patient investigation on this subject in Germany have found expression in the German Feeding Standards. In these it has been attempted to give the needs of various animals, both as to amount of food and amount and proportion of digestible nutrients. The standards compiled by Wolff (Tables I and II) on this subject have been widely published and used in this country, and have, especially of late years, been the subject of discussion and criticism. We have no feeding standards of our own in America, and while the German ones no doubt need to be modified and changed to suit our climate, foods and animals, yet the principle and example are good, and can serve as guides till we have accumulated sufficient data to formulate ones better suited to our particular needs.

It is to be remembered that the feeding standards presented do not represent invariable scientific facts, but are the average results of a great many carefully conducted experiments; then, too, the compositions and coefficients of digestibility of the feeding-stuffs are the averages of analyses and digestion experiments. These facts borne in mind, the feeder will not expect certain definite results from them.

Another observation of interest in connection with feeding standards, is the greater proportion of protein to carbohydrates and fats in the rations for young and growing animals, than in those for grown, fattening, and working ones. This is precisely as would be expected, since the bodily frame work of the young animal is being built up at this stage of growth, and hence requires a larger proportion of protein, or flesh formers.

Nutritive Ratio.

"Total organic matter" in the above table represents the water-free food, minus the ash; the "total nutritive substance" is the sum of digestible protein, carbohydrates, and fats; and the "nutritive ratio" is the ratio of the digestible protein to the sum of the digestible carbohydrates and fats, the fats being previously multiplied by 2.5.*

It will be seen from Table I that the standards are for animals of 1,000 pounds live weight. The standards are to be increased or diminished in proportion as the weight of the animal is greater or less than 1,000. In Table II, they have been thus culculated to correspond with the weights of some animals weighing less than 1,000 pounds.

---

* Experimenters and feeders now generally use factors varying from 2.2 to 2.27 for bringing fats to the same nutritive basis as carbohydrates, and we agree with them that these factors are more nearly correct than 2.5; but we adhere to the latter in order that our ratios may be comparable with those in the German standard.

TABLE I. FEEDING STANDARDS.—ACCORDING TO WOLFF.

Per day and per 1,000 *lbs. live weight.*

	Total organic substance.*	Nutritive (Digestible) Substances.			Total nutritive substance.**	Nutritive ratio.
		Protein.	Carbohydrates.†	Fats.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1. Oxen at rest in stall	17.5	0.7	8.0	0.15	8.85	1 : 12.0
2. Wool sheep, coarser breeds	20.0	1.2	10.3	0.20	11.70	1 : 9.0
Wool sheep, finer breeds	22.5	1.5	11.4	0.25	13.15	1 : 8.0
3. Oxen moderately worked	24.0	1.6	11.3	0.30	13.20	1 : 7.5
Oxen heavily worked	26.0	2.4	13.2	0.50	16.10	1 : 6.0
4. Horses lightly worked	20.0	1.5	9.5	0.40	11.40	1 : 7.0
Horses moderately worked	22.5	1.8	11.2	0.60	13.6	1 : 7.0
Horses heavily worked	25.5	2.8	13.4	0.80	16.2	1 : 6.0
5. Milk cows	24.0	2.5	12.5	0.40	15.40	1 : 5.4
6. Fattening oxen, 1st period	27.0	2.5	15.0	0.50	18.00	1 : 6.5
Fattening oxen, 2d period	26.0	3.0	14.8	0.70	18.50	1 : 5.5
Fattening oxen, 3d period	25.0	2.7	14.8	0.60	18.10	1 : 6.0
7. Fattening sheep, 1st period	26.0	3.0	15.2	0.50	18.70	1 : 5.5
Fattening sheep, 2d period	25.0	3.5	14.4	0.60	18.50	1 : 4.5
8. Fattening swine, 1st period	36.0	5.0	27.5		32.50	1 : 5.5
Fattening swine, 2d period	31.0	4.0	24.0		28.00	1 : 6.0
Fattening swine, 3d period	23.5	2.7	17.5		20.20	1 : 6.5
9. Growing cattle:						
Age. Mos. — *Av. live weight per head.*						
2— 3 — 150 lbs.	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3— 6 — 300 lbs.	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6—12 — 500 lbs.	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12—18 — 700 lbs.	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18—24 — 850 lbs.	24.0	1.6	12.0	0.3	13.9	1 : 8.0
10. Growing sheep:						
5— 6 — 56 lbs.	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6— 8 — 67 lbs.	25.0	2.7	13.3	0.6	16.6	1 : 5.5
8—11 — 75 lbs.	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11—15 — 82 lbs.	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15—20 — 85 lbs.	22.0	1.4	10.4	0.3	12.1	1 : 8.0
11. Growing fat pigs:						
2— 3 — 50 lbs.	42.0	7.5	30.0		37.5	1 : 4.0
3— 5 — 100 lbs.	34.0	5.0	25.0		30.0	1 : 5.0
5— 6 — 125 lbs.	31.5	4.3	23.7		28.0	1 : 5.5
6— 8 — 170 lbs.	27.0	3.4	20.4		23.8	1 : 6.0
8—12 — 250 lbs.	21.0	2.5	16.2		18.7	1 : 6.5

NOTE.—The feeding periods mentioned in the above table have reference to the divisions of the whole time an animal is fed, and their respective lengths will depend on how long the animal is to be fed, its condition at beginning, and the judgment of the feeder.

*Represents the water-free food (or dry matter), less the ash.

†Nitrogen-free extract and crude fiber are taken together to form carbohydrates.

**Sum of the three preceding columns.

TABLE II. FEEDING STANDARDS.
Per day and per head.

		Total organic substance.	Nutritive (Digestible) Substances.			Total nutritive substance.	Nutritive ratio.
			Protein.	Carbohydrates.	Fats.		
Growing cattle: *Age. Mos.*	*Av. live weight per head.*	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
2—3	150 lbs......	3.3	0.6	2.1	0.30	3.00	1:4.7
3—6	300 lbs......	7.0	1.0	4.1	0.30	5.40	1:5.0
6—12	500 lbs.......	12.0	1.3	6.8	0.30	8.40	1:6.0
12—18	700 lbs.......	16.8	1.4	9.1	0.28	10.78	1:7.0
18—24	850 lbs.......	20.4	1.4	10.3	0.26	11.96	1:8.0
Growing sheep:							
5—6	56 lbs.......	1.6	0.18	0.87	0.045	1.095	1:5.5
6—8	67 lbs.......	1.7	0.17	0.85	0.040	1.060	1:5.5
8—11	75 lbs.......	1.7	0.16	0.85	0.037	1.047	1:6.0
11—15	82 lbs......	1.8	0.14	0.89	0.032	1.062	1:7.0
15—20	85 lbs.......	1.9	0.12	0.88	0.025	1.026	1:8.0
Growing fat swine:							
2—3	50 lbs.......	2.1	0.38	1.50		1.88	1:4.0
3—5	100 lbs.......	3.4	0.50	2.50		3.00	1:5.0
5—6	125 lbs.......	3.9	0.54	2.96		3.50	1:5.5
6—8	170 lbs.......	4.6	0.58	3.47		4.05	1:6.0
8—12	250 lbs.......	5.2	0.62	4.05		4.67	1:6.5

NOTE.—The German pound equals 1.1 pounds avoirdupois. The above figures should therefore be increased correspondingly to represent American pounds, but in practice this is probably not necessary, since these weights represent only the approximate needs of the animals.

III. HOW STOCK RATIONS CAN BE CALCULATED.

A ration is the amount of food eaten by an animal per day. Table III contains data in a most available and handy form for compounding rations to correspond with the German standards just given, or with any other formula which may have proven valuable in the experience of the individual feeder, or for estimating the amounts of digestible nutrients the farm animals may now be consuming.

An example or two will make sufficiently clear the calculation and compounding of rations, so that the feeder, by applying results in Table I to whatever foods he may have, can make up rations to correspond with whatever formula he may wish. Suppose we want to compound a ration for a 1,000 pound milch cow, and have corn silage, cowpea-vine hay, corn meal, and cotton-seed meal from which to make it up. By reference to Table III, we find the following amounts of nutrients corresponding to the weights of food taken.

Foods Taken.	Weight. Lbs.	Digestible.		
		Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.
Corn silage	30	.216	3.984	.120
Cowpea-vine hay	12	1.117	4.605	.148
Corn meal	5	.266	2.958	.180
Total	47	1.599	11.547	.448

Using the amounts of corn silage, cowpea-vine hay, and corn meal for making the ration, it falls only slightly below the standard in amounts of carbohydrates and fats, but is notably deficient in protein, so we need to add to it a small quantity of some food rich in protein. Cotton-seed meal is a common food with us, and a good one for this purpose. We will then add to the ration as above, $2\frac{1}{2}$ pounds of cotton-seed meal:

Foods Taken.	Weight. Lbs.	Digestible.		
		Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.
Ration as above	47	1.599	11.547	.448
Cotton-seed meal	$2\frac{1}{2}$	.840	.575	.240
Total	$49\frac{1}{2}$	2.439	12.122	.688
Standard for 1,000-pound cow		2.50	12.50	.40

Nutritive ratio of above ration, 1 to 5.67, obtained thus: (fats .688×2.5) + carbohydrates, (12.122) = 13.842. 13.842 ÷ protein, (2.439) = 5.67.

The $2\frac{1}{2}$ pounds cotton-seed meal are thus seen to bring the ration very near the German standard for a 1,000-pound milch cow. There is a deficiency of carbohydrates, but the excess of fats compensates for this. It is near enough to the standard for all practical purposes. The proportion of the foods in the above ration is not absolute and unchangeable, but may be varied in a number of ways, so as to get practically the same amounts and proportions of digestible nutrients. What we would have understood is that the above is not the only ration that can be made from those foods containing those quantities of digestible nutrients, but a number may be by varying the proportions of them. This the feeder will have to do for himself, taking into account the quantity and foods he may have and the purposes for which he is feeding. The above is merely an example. If the animal weighs 700 or 800 pounds take seven-tenths ($\frac{7}{10}$) or eight-tenths ($\frac{8}{10}$) of the ration for the 1,000-pound animal, or whatever proportion the weight bears to 1,000.

It will be observed that the total "organic matter" was calculated in the feeding standards, but not in the ration presented above. Organic matter is merely a measure of the bulk of the ration, and, if the ration is not made too bulky, or too concentrated, it need not be further considered.

TABLE III. SHOWING AMOUNT OF ORGANIC SUBSTANCE AND OF DIGESTIBLE NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING STUFFS.

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Cowpea-vine hay	1	.7958	.093	.3838	.0124
	2	1.5916	.186	.767	.024
	3	2.3874	.279	1.151	.037
	4	3.1832	.372	1.535	.049
	5	3.9790	.465	1 919	.062
	10	7 9580	.931	3.838	.124
	2,000	1591.60	186.20	767.60	24.80
Crimson clover hay	1	.8142	.1050	.4131	.00898
	2	1.6284	.210	.826	.018
	3	2.4426	.315	1 239	.027
	4	3.2568	.420	1.652	.036
	5	4.0710	.525	2.065	.045
	10	8 1420	1.050	4 131	.089
	2,000	1628.40	210.00	826.20	17.96
Lucerne, or alfalfa hay	1	.8157	.1085	.3716	.0115
	2	1.6314	.217	.743	.023
	3	2 4471	.325	1.114	.034
	4	3.2628	.434	1.486	.046
	5	4.0785	.542	1 858	.057
	10	8.1570	1.085	3 716	.115
	2,000	1631.40	217.00	743.20	23.00
Red-clover hay	1	.8222	.0617	.3602	.0103
	2	1.6444	.123	.720	.020
	3	2 4666	.185	1.080	.030
	4	3.2888	.246	1 440	.041
	5	4.1110	.308	1 801	.051
	10	8 2220	.617	3 602	.103
	2,000	1644.40	123.40	720.40	20.60
Alsike clover hay	1	.8346	.073	.3852	.0136
	2	1.6692	.146	.770	.027
	3	2 5038	.219	1 155	.040
	4	3 3384	.292	1.540	.054
	5	4.1730	.365	1.926	.068
	10	8.3460	.731	3.852	.136
	2,000	1669.20	146.20	770.40	27.20
Soy (soja) beans (sheep)	1	.8451	.2964	.17964	.15886
	2	1.6902	.593	.3593	.3177
	3	2.5353	.889	.5389	.4766
	4	3.3804	1.186	.7186	.6354
	5	4.2255	1.482	.8982	.7943
	10	8 4510	2.964	1.796	1.588
	2,000	1690.20	592.8	359 28	317.72
Soy bean hay	1	.8213	.1127	.4231	.0174
	2	1.6426	.225	.846	.034
	3	2 4639	.338	1 269	.052
	4	3.2852	.450	1.692	.069
	5	4 1065	.563	2.115	.087
	10	8.2130	1.12	4.23	.174
	2,000	1642.60	225.40	846.20	34.80
Soy (soja) bean silage	1	.2296	.03069	.08930	.0159
	2	.4592	.061	.178	.031
	3	.6888	.092	.267	.047
	4	.9184	.122	.357	.063
	5	1.1480	.153	.446	.079
	10	2.2960	.306	.893	.159
	2,000	459.20	61.38	178.60	31.80

TABLE III. Showing Amount of Organic Substance and of Digestible Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Organic Substance. Lbs.	Total Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.
Peanut vine hay	1	.8461	.0653	.4442	.0298
	2	1.6922	.13060	888	.059
	3	2 5383	.195.	1 332	089
	4	3 3844	.261.	1.776	.119
	5	4.2305	.326	2 221	.149
	10	8.4610	.653.	4.442	.298
	2,000	1692.20	.130.60	888.40	59 60
Corn fodder (whole plant)	1	.6349	.0260	.3747	.00903
	2	1.2698	.052	.749	.018
	3	1 9047	.078	1.124	.027
	4	2.5396	.104	1.498	.036
	5	3.1745	.130	1.873	.045
	10	6.3490	.260	3 747	.090
	2,000	1269 80	52.0	749.40	18 06
Corn stover (whole plant, minus ears).	1	.7227	.02806	.4233	.0069
	2	1.4454	.054	.846	.013
	3	2.1681	.084	1.269	.020
	4	2.8908	.112	1.693	.027
	5	3 6135	.140	2.116	.034
	10	7.2270	.280	4.233	.069
	2,000	1445.40	56.12	846.60	13.80
Corn tops, cut above ears	1	.8059	.0308	.4424	.0162
	2	1.6118	.061	.884	.032
	3	2.4177	.092	1.327	.048
	4	3.2236	.123	1.769	.064
	5	4.0295	.154	2.212	.081
	10	8.0590	.308	4.42	.16
	2,000	1611 80	61.60	884.80	32.40
Corn butts or stubble, portion below ears.	1	.5067	.0037	3393	.0086
	2	1.0134	.007	.678	.017
	3	1.5201	.011	1.017	.025
	4	2.0268	.014	1.357	.034
	5	2.5335	.018	1.696	.043
	10	5.0670	.037	3.393	.086
	2,000	1013 40	7.40	678.60	17.20
Corn husks or shucks	1	.8854	.0098	.6473	.0028
	2	1.7708	.019	1.294	.005
	3	2.6562	.029	1.941	.008
	4	3.5416	.039	2.589	.011
	5	4.4270	.049	3.236	.014
	10	8.8540	.098	6.47	.028
	2,000	1770.80	19.60	1,294.60	5.60
Pulled fodder, blades alone	1	.8134	.0534	.4334	.0196
	2	1.6268	.106	.866	.039
	3	2.4402	.160	1 300	.058
	4	3.2536	.213	1.733	.078
	5	4 0670	.267	2.167	.098
	10	8.1340	.534	4.334	.196
	2,000	1626.80	106.80	866.80	39.20
Corn silage, whole plant	1	.2686	.00726	.1328	.0040
	2	.5372	.014	.265	.008
	3	.8058	.021	.398	.012
	4	1.0744	.029	.531	.016
	5	1.3430	.036	.664	.020
	10	2.6860	.072	1.328	.040
	2,000	537.20	14.52	265.60	8.00

TABLE III. SHOWING AMOUNT OF ORGANIC SUBSTANCE AND OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING-STUFFS.—*Continued.*

FOODS.	Weight. Lbs.	Organic substance. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Timothy hay	1	.8557	0303	.4630	.0121
	2	1.7114	.060	.926	.024
	3	2 5671	.090	1.389	.036
	4	3 4228	.121	1.852	.048
	5	4.2785	.151	2.315	.060
	10	8.5570	.303	4.630	.121
	2,000	1711.40	60.60	926.00	24.20
Red top hay (Agrostis vulgaris)	1	.8455	.0465	.4475	.0094
	2	1.6910	.093	.895	.018
	3	2.5365	.139	1.342	.028
	4	3 3820	.186	1.790	.037
	5	4 2275	.232	2 237	.047
	10	8.4550	.465	4.475	.094
	2,000	1691 00	93.00	895 00	18.80
Orchard grass hay	1	.8457	.0408	.4382	.0129
	2	1.6914	.081	.876	.025
	3	2.5371	.122	1.314	.038
	4	3.3828	.163	1.752	.051
	5	4.2285	.204	2.191	.064
	10	8.4570	.408	4.382	.129
	2,000	1691.40	81.60	876 40	25.8
Johnson grass hay	1	.8179	.0337	.3980	.0116
	2	1.6358	.067	.796	.023
	3	2.4537	.101	1.194	.034
	4	3.2716	.134	1.592	.046
	5	4.0895	.168	1.990	.058
	10	8.1790	.337	3.980	.116
	2,000	1635.80	67.40	796.00	23.20
Mixed hays	1	.7986	.0299	.3788	.0104
	2	1.5972	.059	.757	.020
	3	2.3958	.089	1.136	.031
	4	3.1944	.119	1.515	.041
	5	3.9930	.149	1.894	.052
	10	7.9860	.299	3.788	.104
	2,000	1597.20	59.80	757.60	20.80
Mixed hays (horse)	1	.7986	.036	.356	.00376
	2	1.5972	.072	.712	007
	3	2 3958	.108	1.068	.011
	4	3.1944	0.144	1.424	.015
	5	3.9930	.180	1.780	.018
	10	7.9860	.360	3.560	.037
	2,000	1597.20	72.00	712 00	7.520
Cattail, or pearl millet	1	.8331	.0622	4211	.0091
	2	1.6662	.124	.842	.018
	3	2.4993	.186	1.263	.027
	4	3 3324	.248	1 684	.036
	5	4.1655	.311	2.105	.045
	10	8.3310	.622	4.211	.091
	2,000	1666.20	124.40	842 20	18.20
Sorghum fodder (leaves only)	1	.8301	.0584	.4582	.0212
	2	1.6602	.116	.906	.042
	3	2.4903	.175	1.364	.063
	4	3.3204	.233	1.832	.084
	5	4.1505	292	2.291	.106
	10	8.3010	.584	4.783	.212
	2,000	1660.20	116.80	956 60	42.40

TABLE III. SHOWING AMOUNT OF ORGANIC SUBSTANCE AND OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING-STUFFS.—*Continued.*

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Sorghum bagasse	1	.8587	.0047	5218	.0067
	2	1.7174	.009	1 043	.013
	3	2 5761	.014	1.565	.020
	4	3 4348	018	2 087	.026
	5	4.2935	.023	2.609	.033
	10	8 5870	047	5 218	.067
	2.000	1717 40	9 40	1.043.60	13.40
Rice bran (sheep)	1	8038	.0933	.5643	.0782
	2	1.6076	186	1.128	.156
	3	2 4114	.280	1 693	.234
	4	3 2152	.373	2 257	.313
	5	4 0190	.466	2.822	.391
	10	8 0380	.933	5.644	.782
	2,000	1607 60	186 68	1.128.78	.156.48
Oat straw	1	8644	?	.4456	.0088
	2	1 7288	?	.891	.017
	3	2 5932	?	1 336	.026
	4	3 4576	?	1.782	.035
	5	4 3220	?	2 228	.044
	10	8 6440	?	4.456	.088
	2 000	1728 80	?	891.20	17.60
Whole raw cotton-seed	1	.7959	.0983	.2792	.1688
	2	1 5918	.196	.558	.337
	3	2 3877	.294	.837	.506
	4	3.1836	.393	1.116	.675
	5	3 9795	.491	1 396	.844
	10	7 9590	.983	2 792	1 688
	2,000	1591.80	196.60	558 40	337.60
Whole roasted cotton seed	1	.8842	.0756	.2909	.1611
	2	1 7684	.151	.581	.322
	3	2 6526	.226	.872	.483
	4	3.5368	.302	1 163	.644
	5	4.4210	.378	1.454	.805
	10	8 8420	.756	2.909	1.611
	2 000	1768 40	151.20	581.80	322.20
Cotton-seed meal	1	.8560	.3405	.2153	.0919
	2	1.7120	.681	.430	.183
	3	2 6680	1.021	.645	.275
	4	3.4240	1.362	.861	.367
	5	4.2800	1.702	1 076	.459
	10	8.5600	3.405	2.153	.919
	2 000	1712 00	681.00	430.60	183.80
Cotton-seed hulls	1	.8612	.00244	.3232	.0232
	2	1.7224	.0048	.646	.046
	3	2.5836	.0073	.969	.069
	4	3.4448	.0097	1.292	.092
	5	4 3060	0122	1.616	.116
	10	8 6120	.0244	3.232	.232
	2,000	1722.40	48.80	646.40	46.40
Wheat bran	1	.8197	.1197	.3684	.0282
	2	1.6394	.239	.736	.056
	3	2.4591	.359	1.105	.084
	4	3 2788	.478	1.473	.112
	5	4.0985	.598	1.842	.141
	10	8.1970	1.197	3.684	.282
	2,000	1639.40	239.40	736.80	56.40

TABLE III. SHOWING AMOUNT OF ORGANIC SUBSTANCES AND OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING-STUFFS.—*Continued.*

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Corn meal (cows)	1	.8294	.0532	.5916	.0361
	2	1.6588	.106	1.183	.072
	3	2 4882	.159	1.774	.108
	4	3.3176	.212	2.366	.144
	5	4 1470	.266	2 958	.180
	10	8 2940	.532	5 916	.361
	2,000	1658.80	106.40	1.183.20	72.20
Corn meal (pigs)	1	.8294	.0785	.6456	.0321
	2	1 6588	.157	1.291	.064
	3	2 4882	.235	1.936	.096
	4	3 3176	.314	2.582	.128
	5	4.1470	.392	3 228	.160
	10	8.2940	.785	6.456	.321
	2.000	1658.80	157.00	1 291 20	64.20
Corn meal (goats)	1	.8294	.0532	.5916	.0361
	2	1 6588	.106	1.183	.072
	3	2.4882	.159	1.774	.108
	4	3.3176	.212	2 366	.144
	5	4 1470	.266	2 958	.180
	10	8 2940	.532	5.916	.361
	2,000	1658 80	106 40	1.183.20	72.20
Cowpeas (swine)	1	.8197	.1828	.5664	.00708
	2	1.6394	.365	1 132	.014
	3	2.4591	.548	1 699	.021
	4	3.2788	.731	2.266	.028
	5	4 0985	.914	2 832	.035
	10	8.1970	1.828	5 664	.070
	2,000	1639 40	365 6	1.132 8	14.16
Potatoes (swine)	1	.2076	.0155	.1733	--------
	2	4152	.031	.346	--------
	3	.6228	.046	.519	--------
	4	.8304	.062	.693	--------
	5	1.0380	.077	.866	--------
	10	2 0760	.155	1.733	--------
	2,000	415.20	31.04	346.6	--------
Rice bran, or douse (swine)	1	8718	.0638	.7888	.0013
	2	1.7436	.127	1.577	.0026
	3	2.6154	.191	2 366	.003
	4	3.4872	.255	3.155	.005
	5	4.3590	.319	3 944	.006
	10	8 7180	.638	7 888	.0130
	2,000	1743.60	127.68	1.577.6	2.60
Rye bran (swine)	1	.8477	.0972	.4747	.0161
	2	1.6954	.194	.949	.032
	3	2.5431	.291	1.494	.048
	4	3.3908	.389	1 898	.064
	5	4.2385	.486	2.373	.080
	10	8.4770	.972	4 747	.161
	2,000	1695.40	194.0	949.48	32.34
Carrots (horse)	1	.1039	.0113	.0709	--------
	2	.2078	.022	.141	--------
	3	.3117	.034	.212	--------
	4	.4156	.045	.283	--------
	5	.5195	.056	.354	--------
	10	1.0390	.113	.709	--------
	2,000	207.80	22.64	141.84	--------

TABLE III. SHOWING AMOUNT OF ORGANIC SUBSTANCE AND OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING STUFFS.—*Continued.*

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Corn and cob meal (goats)	1	.8396	.0545	.5904	.0297
	2	1.6792	.109	1.180	.059
	3	2 5188	.163	1.771	.089
	4	3.3584	.218	2.361	.118
	5	4 1980	.272	2.952	.148
	10	8 3960	.545	5 904	.297
	2,000	1679.20	109 00	1,180.00	59 40
Corn and cob meal (pigs)	1	8396	.0633	.5638	.0288
	2	1 6792	.126	1.127	.057
	3	2 5188	.189	1.691	.086
	4	3.3584	.253	2.255	.115
	5	4 1980	.316	2.819	.144
	10	8 3960	.633	5.638	.288
	2,000	1679.20	126 60	1,127.60	57.60
Whole corn (pigs)	1	.8793	.0840	.6465	.0362
	2	1.7586	.168	1.293	.072
	3	2 6379	.252	1 939	.108
	4	3 5172	.336	2.586	.144
	5	4 3965	.420	3.232	.181
	10	8 7930	.840	6.465	.362
	2,000	1758 60	168.00	1,293.00	72.40
Corn (horse)	1	8793	.0809	.6515	.0332
	2	1 7586	.161	1.303	.066
	3	2 6379	.242	1.954	.099
	4	3 5172	.323	2.606	.132
	5	4 3965	.404	3.257	.166
	10	8 7930	.809	6 515	.332
	2,000	1758 60	161.80	1 302.92	66.40
Oats	1	8609	0876	.4611	.0394
	2	1.6218	.175	.922	.078
	3	2 5827	.262	1.383	.118
	4	3 4436	.350	1.844	.157
	5	4 3045	.438	2 305	.197
	10	8 6090	.876	4.61	.394
	2 000	1621.80	175 20	922 20	78 80
Oats (horse)	1	.8609	.0904	.4795	.0342
	2	1 6218	.180	.959	.068
	3	2 5827	.271	1.438	.102
	4	3 4436	.361	1 918	.136
	5	4 3045	.452	2 397	.171
	10	8 6090	.904	4.795	0.342
	2 000	1621 80	180.96	959.08	68.40
Cowpeas, ground (horse)	1	.8197	178	.5479	.0019
	2	1 6394	.356	1.095	.003
	3	2 4591	.534	1 643	.005
	4	3.2788	.712	2.191	.007
	5	4 0985	.890	2.739	.009
	10	8 1970	1.780	5 479	0.019
	2,000	1639.40	356 0	1 095 80	3 80
Cowpeas, ground (ruminants)	1	8197	.1827	.5401	.0117
	2	1.6394	.365	1 080	.023
	3	2.4591	.548	1.620	.035
	4	3 2788	.731	2.160	.046
	5	4.0985	.913	2.700	.058
	10	8 1970	1 827	5.401	.117
	2 000	1639.40	365.40	1,080.18	23.48

TABLE III. SHOWING AMOUNT OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2 000 POUNDS OF FEEDING-STUFFS.

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Corn and cob-meal	1	.834	.065	.563	.029
	2	1.668	.129	1 12	.057
	3	2.502	.194	1.788	.086
	4	3.336	.258	2.251	.115
	5	4.170	.323	2.814	.144
	10	8 340	.646	5.628	.287
	2,000	1668.0	129 2	1125.6	57.4
Barley meal	1	.855	.074	.629	.020
	2	1 710	.147	1 258	.039
	3	2.565	.221	1 886	.059
	4	3 420	.294	2.515	.078
	5	4,275	.368	3,244	.098
	10	8 550	.736	6 288	.196
	2,000	1710.0	147 2	1257 6	39.2
Linseed meal (new process)	1	.840	.279	.364	.027
	2	1.680	.558	.727	.055
	3	2 520	.837	1 091	.082
	4	3.360	1 116	1.454	.109
	5	4.200	1.395	1 818	.137
	10	8.400	2.789	3 636	.273
	2,000	1680 0	557.8	727.2	54.6
Peanut meal	1	846	.429	.228	.069
	2	1 692	.858	.456	.137
	3	2.538	1.288	.685	.206
	4	3.384	1 718	.913	.274
	5	4 230	2.147	1.141	.343
	10	8 460	4.294	2.282	.686
	2,000	1692.0	858.8	456.4	137.2
Hominy chops	1	864	.074	.552	.068
	2	1 728	.149	1.105	.136
	3	2.592	.223	1.657	.204
	4	3 456	.298	2 210	.272
	5	4.320	.372	2.762	.340
	10	8 640	.745	5 524	.680
	2 000	1728.0	149 0	1104.8	136.0
Corn and oats (equal parts ground)	1	859	.074	.612	.037
	2	1.718	.148	1.224	.074
	3	2 577	.222	1.836	.112
	4	3.436	.296	2.448	.149
	5	4.295	.369	3.060	.186
	10	8.590	.739	6 120	.372
	2,000	1718 0	147 8	1224.0	74.4
Barley	1	867	.087	.648	.016
	2	1.734	.174	1 296	.032
	3	2.601	.261	1.944	.048
	4	3 468	.348	2.592	.064
	5	4 335	.435	3.241	.080
	10	8.670	.869	6.483	.160
	2,000	1734.0	173.8	1296.6	32.0
Rye	1	.865	.091	.697	.014
	2	1.730	.182	1.394	.027
	3	2.595	.273	2 092	.041
	4	3 460	.365	2.789	.054
	5	4.325	.456	3.486	.068
	10	8.650	.912	6.973	.136
	2,000	1730.	182.4	1394.6	27.2

TABLE III. SHOWING AMOUNT OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING-STUFFS.

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Wheat	1	.877	.102	.692	.017
	2	1.754	.205	1.384	.034
	3	2 631	.307	2 076	.050
	4	3 508	.409	2.768	.067
	5	4.385	.511	3 460	.084
	10	8 770	1.023	6.921	.168
	2,000	1754.	.204.6	1384.2	33.6
Wheat midling	1	.807	.128	.531	.034
	2	1.614	.256	1 063	.068
	3	2 421	.384	1 594	.102
	4	3.228	.512	2.126	.136
	5	4 035	.640	2 657	.170
	10	8 070	1.279	5.315	.340
	2 000	1614.	255.8	1063 0	68.0
Wheat shorts	1	.836	.122	.500	038
	2	1.672	.244	1.000	.077
	3	2 508	.367	1.499	.115
	4	3 344	.489	1 999	.153
	5	4.180	.611	2.499	.191
	10	8.360	1.222	4.998	.383
	2,000	1672.	.244.4	999 6	77.6
Buckwheat midling	1	.820	.173	.266	.045
	2	1 640	.347	.532	.091
	3	2 460	.520	.797	.136
	4	3.280	.694	1.063	.181
	5	4.100	.867	1.334	.227
	10	8 200	1.734	2.658	.454
	2 000	1640.	346.8	531.6	90.8
Beets	1	.121	.012	.088	...
	2	.242	.024	.176	.001
	3	.363	.036	.264	.001
	4	.484	.048	.352	002
	5	605	.060	.440	.002
	10	1.210	.120	.880	.005
	2,000	242.	24.	.176.	1.
Mangel Wurzels	1	.080	.010	.056	.001
	2	.160	.020	.112	.002
	3	.240	030	.168	.003
	4	.320	.040	.224	.004
	5	.400	.050	280	.005
	10	1 600	.100	1.120	.011
	2,000	160.	20.	112.	2.
Turnips	1	.085	.008	.065	.001
	2	.170	016	.129	.002
	3	255	.024	.194	.003
	4	.340	.032	.258	.004
	5	.425	.040	.323	.005
	10	4 250	.400	.646	.011
	2,000	170.	16.	129.	2.
Ruta-bagas	1	.102	.009	.077	.001
	2	.204	.018	.155	.002
	3	.306	.026	.232	.003
	4	.408	.036	.309	.004
	5	.510	.044	387	.005
	10	2.040	.088	.774	.011
	2,000	204.	18.	.155.8	2.

TABLE III. SHOWING AMOUNT OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING-STUFFS.

FOODS.	Weight. Lbs.	Organic Substance. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Wheat straw	1	862	.008	.379	.005
	2	1 724	.016	.758	.009
	3	2 586	.024	1.137	.014
	4	3.448	.032	1.516	.018
	5	4 310	.040	1 895	.023
	10	8.620	.080	3.790	.045
	2 000	1724	32.	758.	9.
Rye straw	1	.897	.007	.427	.004
	2	1 794	.014	.854	.007
	3	2.691	.021	1 281	.011
	4	3.588	.028	1.708	.014
	5	4.485	.035	2 135	.018
	10	8 970	.073	4 270	.035
	2,000	1794.	14.	854.	7.
Hungarian grass hay	1	.863	.045	517	.013
	2	1.626	.090	1.034	.026
	3	2 489	.135	1 551	.039
	4	3 252	.180	2 068	.052
	5	4 115	.225	2.585	.065
	10	8.230	.450	5.170	.130
	2 000	1626.	90	1034.	26.
Full cow's milk (calves)	1	.1402	.0309	.0536	.0534
	2	.2804	.061	.107	.106
	3	4206	.092	.160	.160
	4	.5608	.123	.214	.213
	5	.7010	.154	.268	.267
	10	1.4020	.309	.536	.534
	2,000	280 40	61 8	107.2	106.84
Buttermilk	1	.0795	.0305	.0442	.0025
	2	.1590	.061	.088	.005
	3	.2385	.091	.132	.007
	4	.3180	.122	.176	.010
	5	.3975	.152	.221	.012
	10	.7950	.305	.442	.025
	2,000	159.00	61.00	88.46	5.13
Skim milk (Cream raised by setting)	1	.088	.031	.047	.008
	2	.176	.062	.094	.016
	3	.264	.094	.141	.025
	4	.352	.125	.188	.033
	5	.440	.15[illegible]	.234	.041
	10	.880	.318	.469	.083
	2,000	176.0	62.6	93.8	16.6
Skim milk (Cream raised by separator)	1	.086	.029	.052	.003
	2	.172	.059	.105	.006
	3	.258	.088	.157	.009
	4	.344	.118	.210	.012
	5	.430	.147	.262	.015
	10	.860	.294	.524	.029
	2,000	172 0	58.8	104.8	5.8

TABLE IV. COEFFICIENTS OF DIGESTIBILITY OF FEEDING STUFFS.

FOODS.	Dry matter.	Total protein.	Fats.	Nitrogen-free extract.	Crude fiber.	Ash.	AUTHORITY.
Cowpea-vine hay	59.2	64.5	50.0	70.7	42.9	45.1	N. C. Expt. Sta., Bulletin 87D.
Lucerne, or alfalfa hay	59.4	72.9	51.2	67.9	46.1	.....	N. Y. State Expt. Sta. and O'Brine.
Alsike clover hay	54.9	55.5	53.2	64.1	46.2	...	Maine Expt. Sta., 1886–'87.
Crimson clover hay	62.2	69.1	48.8	71.5	48.7	53.6	N. C. Expt. Sta., Bulletin 87D.
Red clover hay	51.7	49.4	42.6	57.6	47.5	....	Armsby.
Peanut-vine hay	59.9	63.3	65.9	69.5	51.9	20.4	N. C. Expt. Sta., Bulletin 97.
Soy (soja) bean hay	62.4	70.5	41.6	75.4	59.4	23.7	N. C. Expt. Sta., Bulletin 97 and Sturtevant.
Soy (soja) bean silage	59.0	75.8	71.9	52.0	54.8	56.7	N. C. Expt. Sta., Bulletin 87D.
Crab grass hay	54.9	32.0	35.6	52.8	64.4	51.8	N. C. Experiment Station.
Johnson-grass hay	54.5	44.7	39.5	54.4	57.8	56.1	N. C. Expt. Sta., Bulletin 97.
Orchard-grass hay	57.3	59.8	54.6	55.6	61.4	35.0	Me. and N. Y. Expt. Stas., Ann. Reps., 1888, and 8th.
Red-top hay	57.6	60.4	44.2	59.1	61.2	24.3	Maine Expt. Sta., Ann. Rep., 1888, p. 96.
Timothy hay	57.8	49.1	55.5	61.3	53.3	34.6	Maine Expt. Sta., Ann. Rep., 1888–'91, av. 6 determ.
Mixed hays	54.3	47.9	50.0	56.9	47.9	.. ..	N. Y. Expt. Sta., and Sturtevant, 8th Ann. Rep., p. 95.
Meadow (mixed) hay (horse)	50.22	57.54	18.00	58.12	39.02	.. .	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Cat-tail, or pearl millet	62.3	62.6	46.1	59.1	66.5	68.4	N. C. Expt. Sta., Bulletin 97.
Oat straw	50.3	?	38.3	53.2	57.6	.....	Maine Expt. Sta., Ann. Rep., 1886–'87, p. 76.
Corn fodder, whole plant	..	54.0	70.6	63.6	68.5	.	Sturtevant, Woll, and Penn. Sta.*
Corn silage, whole plant	53.2	34.4	66.0	60.5	43.2	26.9	N. C. Expt. Sta., Bulletin 87D.
Corn stover, whole plant, minus ears	61.8	51.3	51.9	63.4	66.7	44.4	Armsby.
Pulled fodder, blades alone	60.0	45.2	59.2	63.4	69.1	26.2	Maryland Expt. Sta. Bul. 20, and N. C. Sta. Bul. 87D.
Crushed corn butts or stubble, portion below ear	66.5	21.0	79.5	69.0	73.5	11.5	Maryland Expt. Sta., Bulletin 20, p. 12.
Corn husks, or shucks	72.0	29.5	32.5	75.0	79.5	16.0	Maryland Expt. Sta., Bulletin 20, p. 12.
Corn tops, cut above ears	57.3	38.7	67.3	57.8	70.9	7.5	Texas Sta., Bul. 15, and Maryland Sta., Bul. 20.
Sorghum bagasse	60.6	13.7	46.4	64.8	63.8	13.4	N. C. Expt. Sta., Bulletin 97.
Sorghum fodder, leaves alone	63.1	60.8	46.7	64.5	70.4	29.5	N. C. Expt. Sta., Bulletin 97.

*Average of Sturtevant, Woll, and Dent fodder, ears glazing; Burrill and Whitman fodder, nubbins glazing; and Burrill and Whitman fodder, by Pennsylvania Station, Annual Report 1890, p. 62.

TABLE IV. COEFFICIENTS OF DIGESTIBILITY OF FEEDING STUFFS.—*Continued.*

Foods.	Dry matter.	Total protein.	Fats.	Nitrogen-free extract.	Crude fiber.	Ash.	Authority.
Green rape	84.8	88.8	48.5	92.0	87.0	62.7	N. C. Experiment Station.
Cotton-seed hulls	41.1	5.9	79.4	34.3	47.4	21.4	Texas and N. C. Stations.
Whole raw cotton seed	66.1	67.9	87.1	49.6	75.5	43.3	N. C. Expt. Sta., Bulletin 87D.
Whole roasted cotton seed	55.9	47.0	71.7	51.4	65.9	....	N. C. Expt. Sta., Bulletin 87D.
Cotton-seed meal	73.3	87.8	89.7	61.5	46.4	31.5	N. C. Expt. Sta., Bulletin 97, and Armsby and Wolff.
Wheat bran	59.3	77.9	73.3	65.8	18.0	....	Me. Expt. Sta., Ann. Repts. 1889 and 1891, pp. 61, 39.
Corn bran	70.5	53.4	72.3	79.6	53.1	....	N. C. Experiment Station.
Rice bran	64.7	62.9	88.6	78.2	29.2	2.4	N. C. Experiment Station.
Rice bran, or douse (sheep)	89.25	77.33	89.31	100.08	67.29	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1118.
Rye bran	67.00	65.96	57.53	74.48	9.01	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Cowpea meal	86.6	82.0	73.9	93.1	64.0	33.5	N. C. Experiment Station.
Corn meal (cows)	84.6	58.3	91.9	87.1	0	....	N. Y. Expt. Sta., 7th Ann. Rep., p. 279.
Corn meal (goats)	86.9	66.9	80.5	94.2	....	....	N. C. Expt. Sta., Bulletin 97.
Corn meal (pigs)	89.5	86.1	81.7	94.2	29.4	....	Maine Expt. Sta., Rept. 1885–'86, p. 61.
Whole corn (pigs)	86.1	79.3	66.6	91.3	43.5	....	Maine and Minn. Expt. Stas., Rept. '85–'6, and Bul. 26.
Corn-and-cob meal (pigs)	75.6	75.7	82.0	83.6	28.5	....	Maine Expt. Sta., Rep. 1885–'86, p. 62.
Corn-and-cob meal (goats)	78.7	65.2	84.6	85.6	47.7	....	N. C. Expt. Sta., Bulletin 97.
Rice	98.30	85.80	70.10	99.60	....	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1110.
Oats	....	77.0	82.0	74.0	17.0	....	German Experiments.
Oats (horse)**	69.36	79.51	71.13	75.08	29.13	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Corn (horse)**	88.72	76.42	61.03	92.11	40.46	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Field beans, ground (horse)	87.07	85.89	13.20	93.55	65.40	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1111.
Field beans (ground) ruminants	88.88	88.05	81.51	91.69	71.89	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1214.
Pease, ground	90.95	88.10	49.22	96.66	68.39	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Soy beans (sheep)	85.05	87.22	94.28	62.18	....	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1113.
Potatoes, solanum tubers (swine)	92.96	72.54	....	98.05	55.11	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Sour milk, clabbered (swine)**	94.6	95.7	95.0	98.5	....	....	Zusammen Setzung und Verd. der Futtermittel von
Cow's milk (calves)**	97.88	96.4	99.8	98.2	....	....	Dr. Th. Dietrich and Dr. J. König.

**Organic substance.

TABLE IV. COEFFICIENTS OF DIGESTIBILITY OF FEEDING-STUFFS.—*Continued.*

Foods.		Dry matter.	Total protein.	Fats.	Nitrogen-free extract.	Crude fiber.	Ash.	Authority.
Mixed rations—								
Crab-grass hay / and cowpea meal	1 / 1	70 9	70.5	54.7	76.5	64.3	45.9	North Carolina Experiment Station.
Crab-grass hay / Corn bran	1 / 2⅓	66 1	48.7	69 1	74.4	59.7	16.5	North Carolina Experiment Station.
Crab grass hay / Rice bran	1 / 1	59.7	52 4	82.3	66.0	56.0	26.3	North Carolina Experiment Station.
Timothy hay / Cotton-seed meal	16 / 1	55.3	50.7	50.1	62.1	48 9	22.8	North Carolina Experiment Station.
Timothy hay / Cotton-seed meal	12 / 1	53.6	55 9	64.1	59.9	47.2	21 2	North Carolina Experiment S ation.
Timothy hay / Cotton-seed meal	8 / 1	48.9	54.9	61.5	55.0	41.7	10.4	North Carolina Experiment Station.
Timothy hay / Cotton-seed meal	4 / 1	51.5	60.59	74.73	57.30	42.73	5 70	North Carolina Experiment Station.
Timothy hay / Cotton-seed meal	2 / 1	59.1	71.42	84.87	66 92	39 45	14.68	North Carolina Experiment Station.
Timothy hay / Cotton-seed meal	1 / 1	61.4	75.60	89.00	68.80	27.80	27.40	North Carolina Experiment Station.

TABLE V. Showing Average Composition of Feeding-Stuffs—American Analyses.

Foods.	No. of analyses.	Percentage composition.							Percentage of digestible matter.					
		Water.	Dry matter.	Total protein.	Fats (Eth. extract.)	N-free extract.	Crude fiber.	Ash.	Dry matter.	Protein.	Fats.	N-free extract.	Crude fiber.	Ash.
Cowpea-vine hay	13	11.90	88.10	14.43	2.49	41.22	21.54	8.42	52.15	9.31	1.24	29.14	9.24	3.79
Crimson clover hay	2	10.85	89.15	15.20	1.84	38.91	25.65	7.73	55.45	10.50	.89	28.82	12.49	4.14
Lucerne, or alfalfa hay	3	11.53	88.47	14.89	2.24	34.18	30.26	6.90	52.55	10.85	1.15	23.21	13.95	------
Red clover hay	35	11.63	88.37	12.50	2.43	40.43	26.81	6.15	45.69	6.17	1.03	23.28	12.73	------
Alsike clover hay	6	8.91	91.09	13.18	2.56	40.48	27.22	7.63	50.00	7.31	1.36	25.95	12.57	------
Soy (soja) bean silage	1	74.20	25.80	4.05	2.23	6.95	9.70	2.84	15.22	3.07	1.60	3.61	5.31	1.61
Soy bean hay	3	12.04	87.96	15.98	4.19	34.39	27.57	5.83	54.89	11.27	1.74	25.93	16.38	1.38
Peanut-vine hay	2	8.34	91.66	10.31	4.52	46.64	23.14	7.05	54.90	6.53	2.98	32.41	12.01	1.44
Corn silage, whole plant	3	71.98	28.02	2.11	.61	16.42	7.72	1.16	14.91	.73	.40	9.93	3.34	0.30
Pulled fodder, blades alone	2	8.94	91.06	11.82	3.31	41.45	24.72	9.72	54.64	5.34	1.96	26.28	17.06	2.56
Corn fodder, whole plant	11	32.19	67.81	4.81	1.28	37.15	20.21	4.32	--	2.60	.90	23.63	13.84	------
Corn stover, whole plant, minus ears	10	22.81	77.19	5.47	1.34	39.90	25.55	4.92	47.70	2.80	.69	25.29	17.04	2.18
Corn butts or stubble, portion below ears*	1	46.74	53.26	1.76	1.08	27.37	20.46	2.59	35.42	.37	.86	18.89	15.04	.30
Corn husks or shuck *	1	8.10	91.90	3.33	0.85	51.55	32.81	3.36	66.17	.98	.28	38.65	26.08	.54
Corn tops, cut above ears	2	12.19	87.81	7.96	2.44	42.16	28.03	7.22	50.32	3.08	1.62	24.37	19.87	.54
Sorghum fodder, leaves alone	1	12.43	87.57	9.60	4.55	44.93	23.93	4.56	55.25	5.84	2.12	28.98	16.84	1.34
Sorghum bagasse	2	11.25	88.75	3.44	1.44	50.47	30.52	2.88	53.78	.47	.67	32.72	19.46	.38
Timothy hay	58	10.21	89.79	6.18	2.19	46.91	30.29	4.22	51.90	3.03	1.21	30.16	16.14	1.46
Red top hay (Agrostis vulgaris)	4	9.52	90.48	7.70	2.14	46.19	28.52	5.93	52.12	4.65	.94	27.30	17.45	1.44
Orchard grass hay	6	9.80	90.20	6.82	2.38	42.12	33.23	5.63	51.68	4.08	1.29	23.42	20.40	1.95
Johnson grass hay	3	12.30	87.70	7.55	2.93	41.62	29.69	5.91	47.80	3.37	1.16	22.64	17.16	3.32
Cat-tail, or pearl millet	2	10.47	89.53	9.94	1.97	36.62	30.78	10.22	55.78	6.22	.91	21.64	20.47	6.99
Mixed hays	10	15.41	84.59	6.25	2.09	40.30	31.21	4.73	45.93	2.99	1.04	22.93	14.95	------
Meadow (mixed) hay (horse)	Same composition as above								40.11	3.60	.37	23.42	12.18	------

*Analyses from Bulletin 20, Maryland Experiment Station.

TABLE V. SHOWING AVERAGE COMPOSITION OF FEEDING-STUFFS—AMERICAN ANALYSES.—*Continued.*

FOODS.	No. of analyses.	PERCENTAGE COMPOSITION.							PERCENTAGE OF DIGESTIBLE MATTER.					
		Water.	Dry matter.	Total protein.	Fats (Eth. extract.)	N-free extract.	Crude fiber.	Ash.	Dry matter.	Protein.	Fats.	N-free extract.	Crude fiber.	Ash.
Oat straw	13	8 84	91.16	3.80	2.29	39.12	41.23	4 72	45.85	?	.88	20.81	23 75	......
Whole raw cotton-seed	1	17.51	82.49	14 48	19.38	25 41	20 30	2.90	51 53	9 83	16.88	12 60	15.32	1.25
Whole roasted cotton-seed	1	9.22	90.68	16.09	22.48	25.78	24 03	2 26	50 69	7 56	16 11	13 25	15.84	..
Cotton-seed meal	4	7 74	92.26	38.78	10.25	30.20	6 37	6.66	67 63	34.05	9.19	18 57	2.96	2 10
Cotton-seed hulls	5	11 50	88.50	4.15	2.92	39 14	39 87	2.38	36 37	.24	2 32	13.42	18.90	.51
Wheat bran	70	12 43	87 57	15 37	3 85	53.44	9 32	5.60	51 92	11 97	2.82	35 16	1.68	......
Corn meal (cows)	63	15.61	84.39	9.12	3.93	67.92	1 99	1.45	71 39	5 32	3.61	59 16	07	......
Corn meal (pigs)	Same composition as for cows.								75 53	7 85	3.21	63 98	.58	......
Corn (digested by horse)	Same composition as for cows.								78.01	8.09	3 32	64 30	0.84	......
Corn meal (digested by goats)	Same composition as for cows.								71.39	5.32	3.61	59.16	.....	......
Whole corn (pigs)	201	10.52	89.48	10.59	5.44	69 81	2 09	1.55	77.04	8.40	3 62	63 74	.91	......
Corn-and-cob meal (goats)	9	14 52	85.48	8 36	3.51	65.03	7.06	1.52	67.27	5 45	2.97	55.67	3 37	......
Corn-and-cob meal (pigs)	Same composition as for goats.								64 62	6 33	2 88	54 37	2 01	......
Oats‡	25	10 94	89.06	11.38	4.81	60.05	9 85	2 97	.....	8 76	3 94	44 44	1.67	......
Oats (horse)	Same composition.								59 71	9.05	3.42	45.08	2.87	......
Rice bran, or douse (sheep)	5	9 65	90 35	12 07	8.76	50.04	9.51	9 97	80 63	9 33	7 82	50.04	6 39	......
Cowpea, a bean, ground (horse)	5	14.81	85 19	20.75	1.44	55.72	4.06	3 22	74.16	17 82	0 19	52.13	2.66	......
Cowpea, a bean, ground (ruminants)	Same composition as for horse.								75.72	18.27	1.17	51.09	2.91	......
Cowpea, ground (swine)	Same composition as for horse.								77.48	18 28	.70	53 86	2.77	......
Soy beans (sheep)	8	10.80	89.20	33.98	16.85	28.89	4.79	4.69	75 86	29 64	15 88	17.96	.....	......
Rye bran (swine)	12	11 64	88.36	14 74	2.81	63.74	3.48	3.59	59.20	9 72	1.61	47.47	.31	......
Rice (swine)	10	12 44	87 56	7 44	0 19	79 20	0.35	0 38	86 07	6 38	.13	78 88	....	......
Potatoes (swine)	12	78 89	21.71	2 14	0 10	17.36	0.56	0.95	19.62	1.55	.....	17.02	.30	......
Buttermilk	1	91.49	8 51	3.19	0 27	4.49	......	0 56	8 05	3 05	.25	4 42	......	......
Carrots (horse)	15	88.59	11 41	1.14	0.42	7 56	1.27	1.02	9 95	1.13	......	7.09	..	.....
Cow's milk, composite (calves)	......	85 26	14.74	3 21	5 37	5.44	......	0.72	14 41	3.09	5 36	5 34	.....	......

‡Compilation of Dr. E. H Jenkins, Annual Report Connecticut Experiment Station, 888.

TABLE V. SHOWING COMPOSITION OF FEEDING-STUFFS—AMERICAN ANALYSES —*Continued.*

FOODS.	No. of analyses.	PERCENTAGE COMPOSITION							PERCENTAGE OF DIGESTIALE MATTER.					
		Water.	Dry matter.	To al protein.	Fats (Eth. extract.)	N-free extract.	Crude fiber.	Ash.	Dry matter.	Protein.	Fats.	N-free extract.	Crude fiber.	Ash.
Crab-grass hay	2	10 31	89.69	6.92	1.62	40.96	32.92	7.27	......	2.21	0.577	21 63	21.20	3.77
Cowpea meal	1	12.63	87 37	22.25	1 59	56.47	3.69	3.37	......	18 25	1 175	52 57	2 36	1 13
Rice bran	1	10.22	89 78	13 50	10.72	46 47	10 86	8.23	......	8.49	9.50	36.65	3 17	0.20
Corn bran	1	10.80	89.20	9 77	5 74	61 96	9 32	2.37	....	5.22	4 15	49 32	4 95	--
Rape (first growth)	1	81.52	18 48	4 02	0.77	8 13	2 29	2 29	......	3.64	0.42	7.63	2 06	1 75
Rape (first growth)	1	85 06	14 94	3 85	0.58	5 87	1.45	2 02	......	3 36	0.25	5.28	1.22	0.99

BULLETIN No. 164 MAY 19, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

The Flora of North Carolina

FROM

Ranunculaceae to Salviniaceae

C. W. HYAMS

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

Alex. Q. Holladay, LL.D., President of the College.*
W. A. Withers, A.M., Acting Director and Chemist.*
F. E. Emery, M.S., Agriculturist.*
W. F. Massey, C.E., Horticulturist.*
Cooper Curtice, D.V.S., M.D. (1) Veterinarian.*
G. S. Fraps, Ph.D., Assistant Chemist.
J. A. Bizzell, B.S., Assistant Chemist.
H. W. Primrose, B.S., Assistant Chemist.
Alex. Rhodes Assistant Horticulturist.
C. W. Hyams, Assistant Botanist
J. M. Johnson, M.S., Assistant Agriculturist.
B. S. Skinner, Farm Superintendent.
J. M. Fix, Secretary.
C. M. Hughes, B.E., Clerk.
Mrs. L. V. Darby, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. Blair, A.M., State Chemist.
C. B. Williams, M.S., Assistant Chemist.
C. D. Harris, B.S., Assistant Chemist.
F. G. Kelly, Assistant Chemist.
W. G. Haywood, B.Litt, Assistant Chemist.
H. E. King, Chief Clerk.
Miss M. S. Birdsong, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

* Member of Station Council.
(1) On leave of absence.

LETTER OF TRANSMITTAL.

THE N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.
THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

RALEIGH, N. C., May 18, 1899.

Prof. W. A. WITHERS, *Acting Director*.

I herewith submit a revision of the Flora of North Carolina, prepared by my assistant, Mr. Hyams The rich Flora of the State has never been fully catalogued. That of Dr. Curtis being up to the present the only attempt in this line. I believe that the present list will be valued by botanists as an addition to our knowledge of the habits of these plants.

Yours truly,

W. F. MASSEY,
Horticulturist, Botanist and Entomologist.

PREFACE.

In the year 1867, Rev. M. A. Curtis published "A Catalogue of the Indigenous and Naturalized Plants of the State," embracing 1,920 species, exclusive of the lower orders. Since this time a very large number of species have been added to the list, as will be shown further on. Such additions have been published, at long intervals, by various parties, and botanists have long desired a complete Flora of the State, and it is the aim of the present work to supply this want.

The number of species here recognized is 2,685, comprising 154 families. This brings up to June, 1899, it is believed, all well established species within our area. In the admission of new species I have pursued a conservative course, and have only admitted those that appear to bear the requisite tests of constancy and persistency in their distinguishing characters. As far as possible the popular, local names have been given, and I have followed the revised nomenclature of Britton and Brown, only in such cases as seemed well founded in botanical priority. It gives me pleasure to submit this work to your consideration, believing it will aid scientists in determining the localities and range of our vegetation to a large extent, and as being, perhaps, the largest local list of plants ever published in the South. I have divided the State into botanical districts, and have indicated the same by the following abbreviations E, C, and W, meaning respectively Eastern, Central and Western. Where a species is found in all the districts the letter A is used. A line running north through Gaston, Alexander and Alleghany counties would divide the Central and Western districts, while one running north through Bladen, Wake and Granville counties would divide the Eastern and Central districts. I have critically examined all the various publications bearing on the subject, and desire to make due acknowledgements to the authors of the same.

Respectfully,

C. W. HYAMS.

THE FLORA OF NORTH CAROLINA.

FROM

RANUNCULACEAE TO SALVINIACEAE,

BY C. W. HYAMS, ASSISTANT BOTANIST.

Flowering Plants.

Class I—Exogeneous Plants.

Order 1.

RANUNCULACEAE. (CROWFOOT FAMILY.)

ATRAGENE Americana, Sims. Purple Virgin's Bower. W.
CLEMATIS ochroleuca, Ait. Dwarf Clematis. C. and W.
ovata, Pursh. Mountain Clematis. W.
Viorna, L. Leather Flower. C. and W.
crispa, L. Blue Jessamine. E.
Virginiana, L. Virgin's Bower. C. and W.
Addisonii, Britton. Brown's Clematis. C.
reticulata, Walt. Smooth Clematis. E.
Catesbyana, Pursh. Hairy Clematis. E.
ANEMONE quinquefolia, L. Wind Flower. W.
Caroliniana, Walt. Carolina Anemone. W.
Virginiana, L. Virginia Anemone. C. and W.
trifolia, L. Mountain Anemone W.
HEPATICA triloba, Chaix. Liverwort. C. and W.
acutiloba, D. C. Acute-lobed Liverwort. C. and W.
THALICTRUM dioicum, L. Early Meadow Rue. W.
Cornuti, L. Tall Meadow Rue. A.
clavatum, D. C. Slender Meadow Rue. W.
macrostylum, Shuttlaw. Meadow Rue. W.
nudicaule, Schwein. Meadow Rue. C.
anemonoides, Michx. E. and C.
coriaceum (Britton) Small. Thick Meadow Rue W.
purpurascens, L. Purple Meadow Rue. W.
ADONIS annua, L. Pheasant's Eye. A.
TRAUTVETTERIA palmata, F. & M. False Bugbane. W.
RANUNCULUS aquatilis, L. White Crowfoot. C.
parviflorus, L. Small-flowered Crowfoot. E. and C.
alismaefolius, Geyer. Spear-leaved Crowfoot. C.
pusillus, Poir. Dwarf Crowfoot. E. and C.
muricatus, L. Spiny-fruited Crowfoot. E. and C.

RANUNCULUS abortivus, L. Smooth Crowfoot. E. and C.
micranthus, Nutt. Rock Crowfoot. E. and C.
recurvatus, Poir. Rough Crowfoot. E. and C.
sceleratus, L. Biting Crowfoot. E.
Pennsylvanicus, L. Bristly Crowfoot. C.
Purshii, Rich. Pursh's Crowfoot. C.
septentrionalis, Poir. Marsh Crowfoot. E. and C.
repens, L. Creeping Crowfoot. A.
repens, L. nitidus. Crowfoot. E.
fascicularis, Mushl. Tufted Crowfoot. C.
hispidus, Michx. Hispid Crowfoot. A.
acris, L. Meadow Crowfoot. C.
palmatus, Ell. Pallmate Crowfoot. E.
Alleghaniensis, Britton. Mountain Crowfoot. W.
bulbosus, L. Bulbous Crowfoot. A.
parvulus, L. Hairy Crowfoot. E
delphinifolius, Torr. Yellow Water Crowfoot. E.
oblongifolius, Ell. Oblong-leaved Crowfoot. E.
BATRACHIUM trichophyllum (Chaix.), Boss. Water Crowfoot. E.
AQUILEGIA Canadensis, L. Columbine Crowfoot. A.
vulgaris, L. Purple Crowfoot. C.
coccinea, Small. Crowfoot. C.
DELPHINIUM azureum, Michx. Blue Lockspur. W.
tricorne, Michx. Dwarf Lockspur. W.
exaltatum, Ait. Tall Lockspur. W.
Consolida, L. Garden Lockspur. A.
HELLEBORUS viridis, L. Green Hellebore. W.
ACONITUM uncinatum, L. Wild Monkshood.. W.
reclinatum, A. Gray. Trailing Monkshood. W.
ZANTHORHIZA apiifolia, L'Her. Yellow Root. A.
HYDRASTIS Canadensis, L. Golden Seal. W.
CALTHA palustris, L. Marsh Marigold. C. and W.
ISOPYRUM biternatum, T. & G. False Rue Anemone. C.
ACTAEA alba (L.), Mill. White Baneberry. W.
rubra (Ait.) Wild. Red Baneberry. W.
CIMICIFUGA racemosa, Ell. Rattle Top. C. and W.
cordifolia, Pursh. Cordate Rattle Top. W.
Americana, Michx. Mountain Rattle Top. W.
MYOSURUS minimus, L. Mouse tail. E.

Order 2.

MAGNOLIACEAE. MAGNOLIA FAMILY.

MAGNOLIA grandiflora, L. Magnolia. E.
glauca, L. Sweet Bay. E.
Umbrella, Lam. Umbrella Tree. A.
acuminata, L. Cucumber Tree. W.
cordata, Michx. Heart-leaved Magnolia. W.

MAGNOLIA Fraseri, Walt. Long-leaved Magnolia. W.
macrophylla, Michx. Large-leaved Magnolia. W.
LIRIODENDRON Tuliplifera, L. Poplar. A.

Order 3.

ANONACEAE. PAPAW FAMILY.

ASIMINA triloba, Dunal. Papaw. C. and W.
parviflora, Dunal. Small Papaw. A.

Order 4.

MENISPERMACEAE. MOONSEED FAMILY.

MENISPERMUM Canadense, L. Moonseed. A.
COCCULUS Carolinus, D. C. Red Moonseed. E. and C.
CALYCOCARPUM Lyoni, Nutt. Cup-seed. C.

Order 5.

BERBERIDACEAE. BARBERRY FAMILY.

BERBERIS Canadensis, Pursh. Barberry. W.
vulgaris, L. European Barberry. C. and W.
CAULOPHYLLUM thalictroides, Michx. Blue Cohosh. W.
DIPHYLLEIA cymosa, Michx. Umbrella Leaf. W.
PODOPHYLLUM peltatum, L. May Apple. A.
JEFFERSONIA diphylla, (L.) Pers. Twin-leaf. W.

Order 6.

NYMPHAEACEAE. WATER LILY FAMILY.

CABOMBA Caroliniana, Gray. Water-shield. E.
BRASENA peltata, Pursh. Water-target. E.
NELUMBIUM luteum, Willd. Water Chinquepin. E.
NYMPHAEA advena, Soland. Yellow Pond Lily. A.
advena, minor, Morong. Small Pond Lily. C.
sagittaefolia, Walt. Arrow-leaved Pond Lilly. E.
odorata, Ait. White Pond Lilly. E. and C.

Order 7.

SARRACENIACEAE. PITCHER PLANT FAMILY.

SARRACENIA purpurea, L. Purple Pitcher Plant. E. and C.
flava, L. Trumpet-leaf. E. and C.
rubra Walt. Red-flowered Trumpet-leaf. S. W.
variolaris, Michx. Spotted Trumpet-leaf. S. E.

Order 8.

DROSERACEAE. SUNDEW FAMILY.

DROSERA filiformis, Raf. Three-leaved Sundew. E.

DROSERA longifolia, L. Long-leaved Sundew.

rotundifolia, L. Round-leaved Sundew. E. and C.

brevifolia, Pursh. Short-leaved Sundew. E and C.

DIONAEA muscipula, Ell. Fly Trap. E.

Order 9.

PAPAVERACEAE. POPPY FAMILY.

ARGEMONE Mexicana, L. Mexican Poppy. E.

SANGUINARIA Canadensis, L. Blood Root. A.

CHELIDONIUM majus, L. Celandine. C.

PAPAVER somniferum, L. Opium Poppy. C. and W.

Rhoeas, L. Corn Poppy. C.

dubium, L. Smooth-fruited Poppy. A.

Argemone, L. Rough-fruited Poppy. E

GLAUCIUM luteum, Scop. Sea Poppy. E.

Order 10.

FUMARIACEAE. FUMITORY FAMILY.

ADLUMIA cirrhosa, Raf Climbing Fumitory. W.

DICENTRA Cucullaria, Torr. Dutchman's Breeches. W.

eximia, Walp. Wild Bleeding heart. W.

Canadensis, Torr. Squirrel Corn. W.

CORYDALIS glauca, Pursh. Pink Corydalis. W.

flavula, Raf Pale Corydalis. W.

aurea, Willd. Golden Corydalis. E.

micranthum (Engllm), Britton. Small-flowered Corydalis. E.

FUMARIA officinalis, L. Fumitory. E.

parviflora, Lam. Small Fumitory. E.

Order 11.

CRUCIFERAE. MUSTARD FAMILY.

NASTURTIUM tanacetifolium, H. & A. Tansy Cress. E.

palustre, D. C. Marsh Cress. E.

lacustre, Gray. Lake Cress. C.

officinale, R. Br. Water Cress. A.

sylvestre, R. Br. Creeping Yellow Cress. E.

hispidum, D. C. Hispid Yellow Cress. E.

Armoracia, Fries. Horseradish. C.

CARDAMINE rhomboidea, D. C. Spring Cress. E.

rotundifolia, D. C. Round-leaved Cress. W.

spathulata, Michx. Spatulate-leaved Cress. W.

hirsuta, L. Bitter Cress. C.

Ludoviciana, Hook. Virginia Bitter Cress. C.

Clematitis, Shuttlw. Mountain Bitter Cress. W.

Pennsylvanica, Muhl. Pennsylvania Bitter Cress. W.

CARDAMINE arenicola, Britton. Sand Bitter Cress. E.
parviflora, L. Small-flowered Bitter Cress. W.
flexuosa, With. Wood Bitter Cress. W.
DENTARIA diphylla, Michx. Pepper Root. W.
laciniata, Muhl. Cut leaved Pepper Root. C. and W.
heterophylla, Nutt. Slender Pepper Root. W.
multifida, Muhl. Ternate-leaved Pepper Root. C.
ARABIS lyrata, L. Rock Cress. C.
Canadensis, L. Sickle Pod. C. and W.
laevigata, D. C. Smooth Rock Cress. C. and W.
Thaliana, L. Thale Cress. C.
hirsuta, Scop. Hairy Rock Cress. W.
Burkii, Porter. Burke's Rock Cress. W.
BARBAREA vulgaris, R. Br. Yellow Rocket. E. and C.
praecox, R. Br. Scurry Grass. C.
stricta, Andrz. Winter Cress. C.
SISYMBRIUM Thaliana, Gaud. Mouse-ear Cress. E. and C.
canescens, Nutt. Tansy Mustard E. and C.
officinale, Scop. Hedge Mustard. E. and C.
Allaria, Scop. Garlic Mustard. E. and C.
DRABA Caroliniana, Walt. Caroline Whitlaw Grass. E. and C.
ramosissima, Deso. Branching Whitlaw Grass. W.
verna, L. Vernal Whitlaw Grass. E and C.
brachycarpa, Nutt. Short-fruited Whitlaw Grass E. and C.
CAMELINA sativa, Crantz. False Flax. E.
SENEBIERA Coronopus, Poir. Wart Cress. E.
didyma. Lesser Wart Cress. A.
LEPIDIUM Virginicum, L. Wild Peppergrass. A.
campestre, R. Br. Field Peppergrass. C.
Ruderale, L. Roadside Peppergrass. E.
CAPSELLA Bursa-pastoris, Moench. Shepherd's Purse. A.
CAKILE maritima, Scop. Sea Kale. E.
ALYSSUM maritinum, L. Sweet Alyssum. C.
SINAPIS nigra, L. Black Mustard. A.
alba, L. White Mustard. A.
arvensis, L. Charlock. A.
juncea, L. Indian Mustard. C.
BRASSICA campestris, L. Turnip. A.
Napus, L. Rape. C.
RAPHANUS sativus. L. Radish. A.
HESPERIS matronalis, L. Dame's Rocket. C.

Order 12.

CAPPARIDACEAE. CAPER FAMILY.

GYNANDROPSIS pentaphylla, D. C. E
POLANISIA graveolens, Raf. Clammy-weed. W.
CLEOME spinosa, L. Spider-flower. C. and W.

Order 13.

VIOLACEAE. VIOLET FAMILY.

VIOLA palmata, L. Early Blue Violet. A.
cucullata, Ait. Hooded Blue Violet. A.
villosa, Walt. Wood Blue Violet. E. and C.
sororia, Willd. Woolly Blue Violet. C.
sagittata, Ait. Arrow-leaved Violet. C.
* ovata, Nutt. Ovate Arrow-leaved Violet. C.
pedata, L. Bird's-foot Violet. A.
rotundifolia, Michx. Round-leaved Violet. W.
blanda, Willd. Sweet White Violet. E. and C.
blanda amoena, LeConte. LeConte's Violet. C.
primulaefolia, L. Primrose-leaved Violet. E. and C.
lanceolata, L. Lance-leaved Violet. E. and C.
hastata, Michx. Halberd-leaved Violet. W.
pubescens, Ait. Hairy Yellow Violet. C. and W.
scabriuscula (T. & G.), Schwein. Smooth Yellow Violet. W.
Canadensis, L. Canada Violet W.
striata, Ait. Striped or Pale Violet. C.
Labradorica, Schrank. American Dog Violet. C. and W.
rostrata, Pursh. Long-spurred Violet. W.
tricolor, L. Pansy. A.
tenella, Muhl. Field Pansy. C. and W.
glaberrima, Ging. Gingin's Violet. C.
tripartita, Ell. Elliott's Violet. C.
canina, L. Pale Dog Violet. C.
canina multicaulis, T. & G. Dog Violet. C.
SOLEA concolor, Ging. Green Violet. A.

Order 14.

CISTACEAE. ROCK ROSE FAMILY.

HELIANTHEMUM majus, B. S. P. Hoary Frostweed. A.
Canadense, Michx. Long-branched Frostweed. E. and C.
corymbosum, Michx. Pine-barren Frostweed. E. and C.
Carolinium, Michx. Carolina Frostweed. E. and C.
HUDSONIA montana, Nutt. Mountain Heather. W.
ericoides. L. Bushy Heather. E.
tomentosa, Nutt. Beach Heather. E.
LECHEA minor, L. Thyme-leaved Pin-weed. E. and C.
racemulosa, Michx. Oblong-fruited Pin-weed. W.
major, Michx. Hairy Pin-weed. E. and C.
thymifolia, Pursh. Beach Pinweed. E.
tenuifolia, Michx. Narrow-leaved Pin-weed. E. and C.
Leggettii, Britt and Hall. Leggett's Pin-weed. E.

Order 15.

PORTULACACEAE. PARSLANE FAMILY.

PORTULACA oleracea, L. Parslane. A.
grandiflora, Hook. Garden Parslane. C. and W.
pilosa, L. Hairy Parslane. E.
TALINUM teretifolium, Pursh. Fame Flower. C. and W.
CLAYTONIA Virginica, L. Spring Beauty. E. and C.
Caroliniana, Michx. Carolina Spring Beauty. W.
SESUVIUM pentandrum, Ell. See Parslane. E.
portulacastrum, L. See Parslane. E.

Order 16.

CARYOPHYLLACEAE. PINK FAMILY.

PARONYCHIA dichotoma, Nutt. Forking Whitlow-wort. W.
argyrocoma, Nutt. Silver Whitlow-wort. W.
herniariodes, Nutt. Hairy Whitlow-wort. E.
ANYCHIA dichotoma, Michx. Forked Chickweed. A.
capillacea, D. C. Slender Forked Chickweed. W.
AGROSTEMMA Githago, L. Corn Cockle. A.
STIPULICIDA setacea, Michx. E.
SILENE stellata, Ait. Starry Campion. C. and W.
ovata, Pursh. Ovate Starry Campion. C. and W.
Virginica, L. Fire Pink. A.
rotundifolia, Nutt. Round-leaved Catchfly. C.
Caroliniana, Walt. Carolina Pink. E. and C.
antirrhina, L. Sleepy Pink. A.
Armeria, L. Sweet William Pink. E. and C.
noctiflora, L. Night-blooming Catchfly. A.
LYCHNIS alba, Mill. White Campion. C.
SAPONARIA officinalis, L. Soapwort. A.
Vaccaria, L. Cow-herb. C.
DIANTHUS Armeria, L. Deptford Pink. C.
barbatus, L. Bunch Pink. C.
ALSINE media, L. Common Chickweed. A.
squarrosa, Feuzl. Barren Sandwort. E.
glabra, Gray. Glabrous Sandwort. W.
Groenlandica, Spreng. Mountain Sandwort. W.
Michauxii, Fenzl. Narrow-leaved Sandwort, C. and W.
ARENNARIA diffusa, Ell. Hairy Sandwort. E.
serphyllifolia, L. Thyme-leaved Sandwort. E. and C.
rubra, L. Sand Spurry. E.
SPERGULA arvensis, L. Pine Cheat. C. and W.
MOLLUGO verticillata, L. Indian Chickweed. C. and W.
SAGINA procumbens, L. Procumbent Pearlwort. C. and W.
decumbens, T. & G. Decumbent Pearlwort. C. and W.
Elliottii, Fenzl. Elliott's Pearlwort. E. and C.

STELLARIA pubera, Michx. Star Chickweed. C. and W.
uniflora, Walt. Marsh Chickweed. E.
CERASTIUM viscosum, L. Mouse-ear Chickweed. A.
semidecandrum, L. Small Mouse ear Chickweed. C.
vulgatum, L. Large Mouse ear Chickweed. A.
nutans, Raf. Nodding Chickweed. A.
arvense, L. Field Chickweed. A.
TISSA marina (L.), Britton. Salt-marsh Spurry. E
SCLERANTHUS annuus, L. German Knotgrass. E.

Order 17.

MALVACEAE. MALLOW FAMILY.

MALVA rotundifolia, L. Dwarf Mallow. A.
sylvestris, L. High Mallow. C. and W.
moschata, L Musk Mallow. C. and W.
CALLIRRHOE triangulata, (Leav.) Gray. Poppy Mallow. W.
NAPAEA dioica, L. Glade Mallow. C.
SIDA spinosa, L. Prickly Sida. A.
rhombifolia, L. Sida. W
Elliotti, T. & G. Elliott's Sida. C. and W.
ABUTILON Avicennae, Gaert. Indian Mallow. C. and W.
MODIOLA multifida, Moench. Bristly-fruited Mallow. E.
KOSTELETZKYA Virginica, Presl. E.
HIBISCUS Moscheutos, L. Swamp Mallow. A.
militaris, Cav. Halberd-leaved Mallow. E,
aculeatus, Walt. E.
Trionum, L. Venice Mallow. A.

Order 18.

TILIACEAE. LINDEN FAMILY.

TILIA Americana, L. American Linden. W.
pubescens, Ait. Hairy Linden. W.
heterophylla, Vent. Mountain Linden. W.

Order 19.

HYPERICACEAE. ST. JOHN'S WORT FAMILY.

ASCYRUM stans, Michx. St. Peter's wort. A.
hypericoides, L. St. Andrew's wort. A.
HYPERICUM Kalmianum, L Kalm's St. John's-wort. W.
prolificum, L. Shrubby Kalm's St. John's-wort. W.
densiflorum, Pursh. Bushy Kalm's St. John's-wort. W.
galioides, Lam. Bed straw St. John's-wort. W.
adpressum, Bart. Creeping St. John's-wort. C. and W.
virgatum, Lam. Virgate St. John's-wort. C. and W.
perforatum, L. Common St. John's-wort. A.

HYPERICUM maculatum, Walt. Spotted St. John's-wort. C. and W.
graveolens, Buckley. Mountain St. John's-wort. W.
multilum, L. Dwarf St. John's-wort. C. and W.
gymnanthum, Engelm. Clasping-leaved St. John's-wort. C.
Canadense, L. Canadian St. John's-wort. W.
Drummondii, T. & G. Drummond's St. John's-wort. W.
Sarothra, Michx. Orange-grass. A.
Virginicum, L. Marsh St. John's-wort. C. and W.
petiolatum, Walt. Larger Marsh St. John's-wort. E. and C.
aureum, Bart. Mucronate St. John's-wort. W.
fasciculatum, Lam. Fascicled St. John's-wort. E.
aspalathoides, Willd. Branching St. John's-wort. E.
ambiguum, Ell. Linear-leaved St. John's-wort. W.
corymbosum, Muhl. Mountain St. John's-wort. W.
Nudiflorum, Michx. Four-angled St. John's-wort. E. and C.
Buckleyi, Curtis. Buckley's St John's-wort. W.
pilosum, Walt. Downy St. John's-wort. E. aud C.
acutifolium, Ell. Larger Virgate St. John's-wort. C.
glomeratum. W.
ELODES campanulata, Pursh. E.
petiolata, Pursh. E.

Order 20.

CAMELLIACEAE. CAMELLIA FAMILY.

GORDONIA Lasianthus, L. Loblolly-Bay. E.
STUARTIA Virginica, Cav. E. and C.
pentagyna, L'Her. W.

Order 21.

MELIACEAE. MAHOGANY FAMILY.

MELIA Azederach, L. China Tree. A.

Order 22.

LINACEAE. FLAX FAMILY.

LINUM usitatissimum, L. Flax. C. and W.
Virginianum, L. Virginia Flax. A.
striatum, Walt. Swamp Flax. C.
sulcatum, Ridd. Sulcate Flax. C. and W.
medium (Plauch.) Britton. Stiff Yellow Flax. E.

Order 23.

OXALIDACEAE. WOOD-SORREL FAMILY.

OXALIS Acetosella, L. White Wood-sorrel. W.

OXALIS violacea, L. Violet Wood-sorrel. C. and W.
corniculata, L. Procumbent Wood-sorrel. E. and C.
filipes, Small. Slender Yellow Wood-sorrel. C.
stricta, L Upright Yellow Wood-sorrel. A.
recurva, Ell. Large-flowered Yellow Wood-sorrel, C.
cymosa, Small. Tall Yellow Wood-sorrel. C.
grandis, Small. Great Yellow Wood-sorrel. W.

Order 24.

GERANIACEAE. GERANIUM FAMILY.

GERANIUM maculatum, L. Crane's-bill Alum-root. C. and W.
Carolinianum, L. Carolina Crane-bill. A.
dissectum, L. W.
Robertianum, L. Herb Robert. C.
Columbinum, L. Long-stalked Crane's-bill.
Molle, L. Crane's-bill. W.
ERODIUM cicutarium, L. Stork's-bill. E. and C.

Order 25.

BALSAMINACEAE. BALSAM FAMILY.

IMPATIENS pallida, Nutt. Pale Touch-me-not. W.
fulva, Nutt. Spotted Touch-me-not. A.

Order 26.

RUTACEAE. RUE FAMILY.

XANTHOXYLUM Americanum, Mill. Prickly Ash. W.
Clava-Herculis, L. Southern Prickly Ash. E.
Clava-Herculis Fruticosum, Gray. Shrubby Prickly Ash. E.
PTELIA trifoliata, L. Wafer-ash. A.

Order 27.

SIMARUBACEAE. AILANTHUS FAMILY.

ALIANTHUS glandulosa, Desf. Tree-of-Haven. A.

Order 28.

ANACARDIACEAE. SUMAC FAMILY.

RHUS copallina, L. Upland Sumac. A.
typhina, L. Staghorn Sumac. C. and W.
glabra, L. Scarlet Sumac. C, and W.
aromatica, Ait. Fragrant Sumac. W.
aromatica mollis, Gray. Fragrant Sumac. C.
Vernix, L. Poison Sumac. A.
radicans, L Poison Ivy. A.
Toxicodendron, L. Poison Oak. A.
pumila, Michx. Hairy Sumac. E and C.
Cotinoides, Nutt. Smoke-tree. C.

Order 29.

VITACEAE. VINE FAMILY.

VITIS Labrusca, L. Fox Grape. A.
aestivalis, Michx. Summer Grape. A.
cordifolia, Michx. Frost Grape. A.
rotundifolia, Michx. Muscadine Grape. A.
bicolor, LeConte. Winter Grape. A.
Baileyana, Munson. Bailey's Grape. W.
CISSUS Ampelopsis, Pers. Simple Ampelopsis. E.
stans, Pers. Pepper-vine. E.
AMPELOPSIS quinquefolia, Michx. Virginia Creeper. A.

Order 30.

RHAMNACEAE. BUCKTHORN FAMILY.

BERCHERIA volubilis, D. C. Supple Jack. E. and C.
RHAMNUS minutiflorus, Michx. Vine-like Buckthorn. E.
Carolinianus, Walt. Carolina Buckthorn. A.
lanceolata, Pursh. Lance-leaved Buckthorn. C.
CEANOTHUS Americanus, L. Red-root. A.

Order 31.

CELASTRACEAE. STAFF-TREE FAMILY.

EUONYMUS Americanus, L. Strawberry Bush. A.
atropurpureus, Jacq. Purple Strawberry Bush. C.
Europaeus, L. Spindle Tree. C.
CELASTRUS scandens, L. Bittersweet. W.
PACHYSTIMA Canbyi, Gray. Canby's Mountain Lover. W.

Order 32.

ILICACEAE. HOLLY FAMILY.

ILEX opaca, Ait. American Holly. A.
Cassine, L. Dahoon Holly. E.
vomitoria, Ait. Yaupon Holly. E.
glabra, L. Inkberry Holly. E. and C.
decidua, Walt. Meadow Holly. E. and C.
monticola, Gray. Large-leaved Holly. W.
mollis, Gray. Broad-leaved Holly. W.
laevigata, Gray. Smooth Winterberay. E.
myrtifolia, Walt. Myrtle-leaved Holly. E.
ambigua, Chapm. Serrate-leaved Holly. E.
longipes, Chapm. Smooth-leaved Holly. E.
Amelanchier, Curtis. Amelanchier Holly. E
verticillata, Gray. Black Alder. A.
Beadlei, Ashe. Beadle's Holly. C. and W.
lucida (Ait), T. & G. Inkberry. E.

Order 33.

CYRILLACEAE. CYRILLA FAMILY.

CYRILLA racemiflora, Walt. Leatherwood. E.

Order 34.

STAPHYLEACEAE. BLADDER-NUT FAMILY.

STAPHYLEA trifolia, L. Bladder-nut. A.

Order 35.

SAPINDACEAE. SOAP BERRY FAMILY.

CARDIOSPERNUM Halicacabum, L. Balloon Vine. C.
Æsculus glabra, Willd. Fetid Buckeye. W.
octandra, Marsh. Sweet Buckeye. W.
Pavia, L. Red Buckeye. C. and W.
ACER saccharinum, L. Silver Maple. W.
rubrum, L. Red Maple. A.
Saccharum, Marsh. Sugar Maple. W.
Saccharum Floridanum, Small. Sugar Maple. C.
Pennsylvanicum, L. Goasefoot Maple. W.
spicatum, Lam. Mountain Maple. W.
Negundo, L. Ash-leaved Maple. A.

Order 36.

POLYGALACEAE. MILKWORT FAMILY.

POLYGALA cymosa, Walt. Tall Pine barren Milkwort.
ramosa, Ell. Low Pine-barren Milkwort.
lutea, L. Orange Milkwort.
cruciata, L. Marsh Milkwort.
brevifolia, Nutt. Short-leaved Milkwort.
verticillata, L. Whorled Milkwort.
ambigua, Nutt. Loose spiked Milkwort.
incarnata, L. Pink Milkwort.
sanguinea, L. Purple Milkwort.
Curtissii, Gray. Curtiss' Milkwort.
Mariana, Mill. Maryland Milkwort.
Nuttallii, T. & G. Nuttall's Milkwort.
Senega, L. Seneka Snakeroot.
polygama, Walt. Racemed Milkwort.
paucifolia, Willd. Fringed Milkwort.

Order 37.

LEGUININOSAE. PULSE FAMILY.

CROTALLARIA sagittalis, L. Rattle-box. E. and C.
ovalis, Pursh. Prostrate Rattle-box. C. and W.
LUPINUS perennis, L. Wild Lupine. E. and C.
perennis gracilis, Nutt. Slender Lupine. E. and C.

LUPINUS villosus, Willd. Hoary Lupine. E. and C.
diffusus, Nutt. Prostrate Lupine. E. and C.
MEDICAGO lupulina, L. Black Medic. E. and C.
denticulata, Willd. Toothed Medic. E. and C.
sativa, L. Purple Medic. E and C.
CYTISSUS scoparius, L. Scotch Broom. C. and W.
MELILOTUS alba, Desv. White Melilot. A.
officinalis, Lam. Yellow Mellilot. A.
parviflora, D sf. Annual Melilot. A.
Indica, All. Indian Melilot. E.
TRIFOLIUM agrarium, L. Yellow Hop Clover. A.
procumbens, L. Smaller Hop Clover. A.
dubium, Sibth. Least Hop Clover. A.
incarnatum, L. Crimson Clover. A.
arvense, L. Rabbit-foot Clover. A.
pratense, L Red Clover. A.
reflexum, L. Buffaloe Clover. A.
hybridum, L. Alsatian Clover. A.
Carolinianum, Michx. Carolina Clover. A.
repens, L. White Clover. A.
HOSACKIA Purshiana, Beuth. Trefoil. C.
LOTUS Helleri, Britton. Heller's Lotus. C.
PSORALEA melilatoides, Michx. Psoralea. C.
Onobrychis, Nutt. Psoralea. C.
Canescens, Michx. Psoralea. E.
Lupinellus, Michx. Psoralea. E.
PETALOSTEMON corymbosus, Michx. E.
corymbosus trifoliatus, Chapm. E.
AMORPHA fruticosa, L False Indigo. A.
herbacea, Walt. Lead Plant. E.
glabra, Desf. Lead Plant. W.
virgata, Small. Lead Plant. W.
ROBINIA Pseudacacia, L. Locust. A.
viscosa, Vent. Clammy Locust. W.
hispida, L. Moss Locust. C. and W.
hispida rosea, Pursh Rose Locust. C. and W.
WISTARIA frutescens, D. C. American Wisteria. E. and C.
TEPROSIA Virginica, Pers. Goat's Rue. A.
spicata, T. & G. Hirsute Goat's Rue. C. and W.
hispidula, Pursh. Aispid Goat's Rue. E. and C.
ambigua, Curtis. Hoary Goat's Rue. E. and C,
INDIGOFERA Caroliniana, Walt. Carolina Indigo. E.
tinctoria, L. Indigo. E
Anil, L. Indigo. E.
SESBANIA vesicaria, Ell. Sesban. E.
macrocarpa, Muhl. Sesban. E.
punicea, Beuth. Sesban. E.
ASTRALAGUS Canadensis, L. Milk Vetch. W.

ASTRALAGUS glaber, Michx. Vetch. E.
VICIA sativa, L. Common Vetch. A.
hirsuta, Koch. Hairy Vetch. E.
Cracca, L. Cow Vetch. E. and C.
Americana, Muhl. American Vetch. E. and C.
Caroliniana, Walt. Carolina Vetch. A.
tetrasperma, Moluch. Slender Vetch. E. and C.
angustifolia, Roth. Smaller Common Vetch. E. and C.
LATHYRUS venosus, Muhl. Veiny Pea. C.
myrtifolius, Muhl. Myrtle-leaved Pea. W.
AESCHYNOMENE hispida, Willd. Jointed Vetch. C.
ZORNIA tetraphylla, Michx. Zornia. E.
STYLOSANTHES elatior, Swartz. Pencil Flower. A.
riparia, Kearney. Pencil Flower. W.
LESPEDEZA repens, Bart. Creeping Bush-clover. A.
violacea, Pers. Violet Bush-clover. A.
reticulata, Pers. Bush clover. A.
Sturei, Nutt. Sture's Bush clover. E. and C.
striata, Hook & Arn. Japan Bush-clover. A.
hirta, Ell. Hairy Bush-clover. E. and C.
hirta oblongifolia, Britton. Bush-clover. E. and C.
capitata, Michx. Round-headed Bush-clover. C. and W.
capitata sericea, Hook & Arn. Bush-clover. E.
procumbens, Michx. Trailing Bush-clover. E. and C.
Nuttallii, Darl. Nuttall's Bush clover. E.
frutescens (L.), Britton. Wand-like Bush-clover. E. and C,
Virginica (L.), Britton. Slender Bush-clover. E. and C.
angustifolia (Pursh.), Ell. Narrow-leaved Bush-clover. E. and C.
DESMODIUM nudiflorum, D. C. Naked Beggar's-tick. A.
acuminatum, D. C. Pointed-leaved Beggar's tick. A.
pauciflorum, D. C. Few flowered Beggar's-tick. A.
lineatum, D. C. Sand Beggar's-tick. C.
rotundifolium, D. C. Prostrate Beggar's-tick. A.
ochroleucum, Curtis. Cream-flowered Beggar's-tick. C.
humifusum, Beck. Trailing Beggar's-tick. E. and C.
strictum, D. C. Stiff Beggar's-tick. E.
sessilifolium, T. & G. Sessile-leaved Beggar's-tick. E.
canescens, D. C. Hoary Beggar's-tick. A.
bracteosum, D. C. Bracted Beggar's-tick. C.
paniculatum, D. C. Panicled Beggar's-tick. E.
paniculatum Chapmani, Britton. Chapman's Beggar's-tick. E.
paniculatum pubens, Vail. Pabescent Beggar's-tick. E.
laevigatum, D. C. Smooth Beggar's-tick. A.
rhombifolium, D. C. Rhomb leaved Beggar's-tick. E.
viridiflorum, Beck. Violet-leaved Beggar's-tick. C.

DESMODIUM Dillenii, Darl. Dillen's Beggar's-tick. A.
Canadense, D. C. Canadian Beggar's-tick. A.
rigidum, D. C. Rigid Beggar's tick. A.
Marylandicum, Boott. Smooth Beggar's-tick. E.
ciliare, D. C. Hairy Beggar's tick. E. & C.
tortuosum, D. C. A.
cuspidatum, T. & G. A
glabellum, D. C. E.
tenuifolium, T. & G. E.
RHYNCHOSIA tomentosa, H. & A. Twining Rhynchosia. A.
erecta, D. C. Erect Rhynchosia. A.
simplicifolia, Wood. Round-leaved Rhynchosia. E. and C.
PHASEOLUS perennis, Walt. Wild Bean. A.
helvolus, L. Trailing Wild Bean. A.
umbellatus, Britton. Pink Wild Bean. E.
APIOS tuberosa, Moluch. Ground Nut. A.
VIGNA luteola, Benth. E.
ERYTHRINA herbacea, L. E.
CLITORIA Mariana, L. Partridge Pea. A.
CENTROSEMA Virginiana, Benth. Virginia Partridge Pea. C. and W.
AMPHICORPAEA monoica, Nutt. Hog Pea. E. and C.
GALACTIA glabella, Michx. Milk Pea. E. and C.
pilosa, Ell. Downy Milk Pea. E. and C.
mollis, Michx. Hoary Milk Pea. E.
sessiliflora, T. & G. Sessile-flowered Milk Pea. E.
BAPTISIA lanceolata. Wild Indigo. E.
villosa, Ell. Villous Wild Indigo. E.
tinctoria, R. Br. Yellow Wild Indigo. A.
alba, R. Br. White Wild Indigo. W.
leucantha, T. & G. Largea Wild Indigo. E. and C.
THERMOPSIS Caroliniana, Curtis. Mountain Thermopsis. W.
fraxinifolia, Curtis. Smaller Mountain Thermopsis. W.
mollis, Curtis. Hairy Thermopsis. C.
CLADRASTIS tinctoria, Raf. Yellow wood. W.
CERCIS Canadensis, L. Judas Tree. C. and W.
CASSIA nictitans, L. Sensitive Pea. A.
Chamaecrista, L. Large flowered Sensitive Pea. A.
obtusifolia, L. Low-flowered Sensitive Pea. C.
Marylandica, L. Wild Senna. C. and W.
occidentalis, L. Coffee Senna. W.
aspera, Ell. Hirsute Sensitive Pea. A.
GLEDITSCHIA triacanthos, L. Honey Locust. C. and W.
monosperma, Walt. Swamp Locust.
MIMOSA. C.
SCHRANKIA uncinata, Willd. Sensitive Brier.
angustata, T. & G. Narrow-leaved Sensitive Brier. W.

Order 38.

ROSACEAE. ROSE FAMILY.

CHRYSOBALANUS oblongifolius, Michx. E.
PRUNUS Americana, Marsh. Wild Red Plum. A.
Chicasa, Michx. Hog Plum. A.
Pennsylvanica, L. Wild Red Cherry. W.
serotina, Ehrhart. Wild Black Cherry. W.
Virginiana, L. Choke Bherry. A.
Caroliniana, Ait. Mock Orange. W.
cuneata, Raf. Appalachian Cherry. W.
Avium, L. Sweet Cherry. W.
AMYGDALUS Persica, L. Peach. A.
SPIRAEA opulifolia, L. Ninebark. C. and W.
opulifolia ferruginea, Nutt. Pubescent Ninebark. C. and W.
corymbosa, Raf. Corymbed Spiraea. W.
tomentosa, L. Hardback. A.
salicifolia, L. Willow leaved Spiraea. A.
lobata, Murr. Lobed Spiraea. W.
Aruncus, L. Goat's-beard Spiraea. C. and W.
Virginiana, Britton. Virginia Spiraea. W.
GILLENIA trifoliata, Moluch. Indian Physic. C. and W.
stipulacea, Nutt. American Ipecac. C- and W.
AGRIMONIA hirsuta, Bick. Tall hairy Agrimony. C. and W.
striata, Michx. Woodland Agrimony. A.
pumila, Muhl. Small-fruited Agrimony. E. and C.
mollis, T. & G. Soft Agrimony. W.
parviflora, Soland. Many flowered Agrimony. C. and W.
Eupatoria, L. European Agrimony. C. and W.
SANGUISORBA Canadensis, L. American Burnet. W.
ALCHEMILLA arvensis, L. Firegrass. A.
GEUM Virginianum, L. Virginia Avens. C.
album, Gmelin. White Avens. C and W.
flavum, Porter Cream Avens. W.
geniculatum, Mich. Hairy Avens. W.
vernum, T. & G Spring Avens. W.
radiatum, Michx. Roan Mountain Aolus. W.
WALDSTEINIA fragarioides, Tratt. Barren Strawberry. W.
parviflora, Small. Southern Dry Strawberry. W.
POTENTILLA Norvegica, L. Rough Cinquefoil. A.
Canadensis, L. Field Cinquefoil. A.
Canadensis pumila, T. & G. Cinquefoil. A.
tridentata, Soland. Three toothed Cinquefoil. W.
recta, L. Rough-fruited Cinquefoil. W.
FRAGARIA Virginiana, Duch. Virginia Strawberry. A.
vesca, L. European Strawberry. A.
Indica, Andr. Indian Strawberry. A.
RUBUS odoratus, L. Rose-flowering Raspberry. W.

RUBUS strigosus, Michx. Wild Red Raspberry. W.
occidentalis, L. Black Raspberry. W.
villosus, Ait. High Bush Blackberry. A.
frondosus, Bigil. Bracted Blackberry. A.
Millspaughii, Britton. Millspaugh's Blackberry. W.
parviflorus, Walt. Sand Blackberry E. and C.
hispidus, L. Swamp Blackberry. W.
trivialis Michx. Low-bush Blackberry. A.
Baileyanus, Britton. Bailey's Blackberry. C.
Canadensis, L. Dewberry. A.
ROSA setigera, Michx. Climbing Rose. C.
Carolina, L Swamp Rose. A.
rubiginosa, L. Sweetbrier Rose. C.
humilis, Marsh. Pasture Rose. A.
laevigata, Michx. Cherokee Rose. A.
CRATAEGUS Crus-Galli, L Cockspur Thorn. A.
spathulata, Michx. Small-fruited Haw. E. and C.
punctata, Jacq. Large-fruited Haw. W.
cordata, Ait. Washington Haw. C. and W.
rotundifolia, Borck. Haw. W.
Oxycantha, L May Thorn. C.
elliptica. Ait. May Thorn. W.
apiifolia, Michx. Parsley Haw. E. and C.
coccinea, L. Red Haw. A
glandulosa, Willd. Glandular Haw. C. and W.
macracantha, Lodd. Long-spine Haw. C.
mollis, Scheele. Red-fruited Haw. C.
tomentosa, L. Pear Haw. C.
tomentosa Chapmanii, Beadle. Chapman's Haw. W.
flava, Ait. Yellow Haw. A.
uniflora, Muluch Dwarf Haw. E and C.
Vailiae, Britton. Vail's Haw. C.
collina, Chapm. Haw. W.
PYRUS Americana, D. C. Mountain Ash. W.
angustifolia, Ait. Narrow-leaved Crab Apple. C.
coronaria, L. American Crab Apple. C. and W.
Malus, L. Common Apple. C.
arbutifolia, L. f. Red Choke-berry. C.
arbutifolia nigra, Willd. Black Choke-berry. C. and W.
arbutifolia erythrocarpa, Chap. Choke-berry. C. and W.
AMELANCHIER Canadensis, Medic. June berry. A.
Botryapium, D. C. Shad-bush. A.
rotundifolia, Roem. Round-leaved Shad-bush. A.

Order 39.

CALYCANTHACEAE. ALL SPICE FAMILY.

CALYCANTHUS floridus, L. Sweet Shrub. A.
laevigatus, Willd. Pubescent Sweet Shrub. C. and W.
glaucus, Willd. Smooth Sweet Shrub. C. and W.

Order 40.

SAXIFRAGACEAE. SAXIFRAGE FAMILY.

ASTILBE decandra, Don. Goat's Beard. C. and W.
SAXIFRAGA Pennsylvanica, L. Pennsylvania Saxifrage. C.
micranthifolia, B S. P. Lettuce Saxifrage. W.
Virginiensis, Michx. Early Saxifrage. C. and W.
Grayana, Britton. Gray's Saxifrage. W.
Michauxii, Britton. Michaux's Saxifrage. W.
Careyana, Gray. Carey's Saxifrage. W.
HEUCHERA Americana, L. American Heuchera. C. and W.
villosa, Michx. Hairy Heuchera. C. and W.
Curtissii, Gray. Curtiss' Heuchera. W.
Rugellii, Shuttlw. Rugel's Heuchera. W.
pubescens, Pursh. Downy Heuchera. W.
hispida, Pursh. Rough Heuchera. W.
BOYKINIA aconitifolia, Nutt. Aconite Saxifrage. W.
TIARELLA cordifolia, L. False Nitre-wort. W.
MITELLA diphylla, L. True Nitre-wort. W.
CHRYSOSPLENIUM Americanum, Schw. Golden Saxifrage. W.
ITEA Virginica, L. Virginia Willow. A.
HYDRANGEA arborescens, L. Wild Hydrangea. C. and W.
radiata, Walt. Downy Hydrangea. W.
DECUMARIA barbara, L. Decumaria. E. and C.
PHILADELPHUS grandiflorus, Willd. Large-flowered Syranga. W.
hirsutas, Nutt. Hairy Syringa. W.
inodorus. L. Scentless Syringa. C. and W.
coronarius, L. Gordon Syringa. C.
RIBES Cynosbati, L. Wild Gooseberry. W.
rotundifolium, Michx. Eastern Wild Gooseberry. W.
prostratum, L'Her. Fetid Gooseberry. W.
resinosum, Pursh. Resinous Gooseberry. W.
Uva-crispa, L. Garden Gooseberry. C.
floridum, L'Her. Wild Black Currant. C.
rubrum, L. Red Currant. C.

Order 41.

PARNASSIACEAE. PARNASSIA FAMILY.

PARNASSIA Caroliniana, Michx. Grass-of-Parnassus. A.
asarifolia, Vent Mountain Grass-of-Parnassus. W.
grandiflora, D. C. Large-leaved Grass-of-Parnassus. W.

Order 42.

CRASSULACEAE. ORPINE FAMILY.

SEDUM roseum, Scop. Rosewort. W.
telephioides, Michx. American Orpine. W.
pulchellum, Michx. Widow's Cross. W.
ternatum, Michx. Wild Stonecrop. W.

SEDUM Nevii, Gray. Nevius' Stonecrop. W.
Rhodiola, D. C. Canby's Stonecrop. W.
PENTHORIUM sedioides, L. Virginia Stonecrop. A.
BRYOPHYLLUM calycinum, Salisb. Bryophyllum. C.
DIAMORPHIA pusilla, Nutt. Diamorpha. C. and W.

Order 43.

HAMAMELACEAE. WITCH HAZEL FAMILY.

HAMAMELIS Virginica, L. Witch Hazel. A.
FOTHERGILLA alnifolia, L. Dwarf Alder. E. and C.
monticola, Ashe. Dwarf Alder. W.
LIQUIDAMBAR Styraciflua, L. Sweet Gum. A.

Order 44.

MELASTOMACEAE. DEER GRASS FAMILY.

RHEXIA Mariana, L. Maryland Meadow-Beauty. A.
Virginica, L. Virginia Meadow-Beauty. A.
glabella, Michx. Purple Meadow-Beauty. E.
ciliosa, Michx. Ciliate Meadow-Beauty. E. and C.
lutea, Walt. Yellow Meadow-Beauty. E.

Order 45.

LYTHRACEAE. LOOSESTRIFE FAMILY.

DIDIPLIS linearis, Raf. Water Purslane. E.
AMMAINA humilis, Michx. Ammania. E.
Koehnei, Britton. Koehne's Ammania. E.
latifolia, L. Ammania. E.
LYTHRUM alatum, Pursh. Angled Loosestrife. A.
lineare, L Linea Loosestrife. E.
NESAEA verticillata, H. B. K. Swamp Loosestrife. E. and C.
CUPHEA viscosissima, Jacq. Wax-weed. C. and W.

Order 46.

HALORAGEAE. WATER-MILFOIL FAMILY.

PROSERPINACA palustris, L. Mermaid-weed. E.
pectinacea, Lam. Cut-leaved Mermaid-weed. E.
MYRIOPHYLLUM verticillatum, L. Whorled Water-Milfoil. E.
spicatum, L. Spiked Water-Milfoil. E.
heterophyllum, Michx. Various-leaved Water-Milfoil. E.
scabratum, Michx. Pinnate Water-Milfoil. E.

Order 47.

ONAGRACEAE. EVENING PRIMROSE FAMILY.

GAURA biennis, L. Biennial Gaura. W.
filipes, Spach. Michaux's Gaura. C.
angustifolia, Michx. Field Gaura. C.

Oenothera biennis, L. Hairy Evening Primrose. A.
humifusa, Nutt. Seaside Evening Primrose. E. and C.
sinuata, L. Sinuate Evening Primrose. E. and C.
glauca, Michx. Smooth Evening Primrose. W.
fruticosa, L. Common Evening Primrose. A.
linearis, Michx. Narrow Evening Primrose. A.
pumila, L. Small Evening Primrose. C.
grandiflora, Ait. Grand Evening Primrose. A.
longipedicellata, Small Long-stemmed Evening Primrose. W.
pilosella, Raf. Mountain Evening Primrose. W.

Epilobium strictum, Muhl. Soft Willow-herb. W.
Coloratum, Muhl. Purple Willow-herb. W.
angustifolium, L. Tall Willow-herb. W.
palustre(L)lineare, Gray. Mountain Willow-herb. W.

Jussiaea decurrens, D. C. Primrose-Willow. A.
diffusa, Forkl. Floating Primrose-Willow. E.

Ludwigia palustris, Ell. Marsh Parslane. A.
alternifolia, L. Alternated Ludwigia. A.
virgata, Michx. Terete Ludwigia. E.
hirtella, Raf. Hairy Ludwigia. E.
linearis, Walt. Linear-leaved Ludwigia. E.
linifolia, Poir. Smooth Ludwigia. E.
pilosa, Walt. Tomentose Ludwigia. E.
sphaerocarpa, Ell. Globe-fruited Ludwigia. E. and C.
capitata, Michx. Capitate Ludwigia. E. and C.
alata, Ell. Wing-stemmed Ludwigia. E.
microcarpa, Michx. Petalless Ludwigia. E. and C.
arcuata, Walt. Curve podded Ludwigia. E.

Circaea Lutetiana, L. Enchanter's Nightshade. C. and W.
alpina, L. Lesser Enchanter's Nightshade. C. and W.

Order 48.

TURNERACEAE. TURNERA FAMILY.

Pirigueta fulva, Chapm. Pirigueta. E.

Order 49.

PASSIFLORACEAE. PASSION FLOWER FAMILY.

Passiflora incarnata, L May Pop. A.
lutea, L. Small May Pop. A.

Order 50.

CUCURBITACEAE. GOURD FAMILY.

Lagenaria vulgaris, Sering. Gourd. A.
Melothria pendula, L. Melothria. E.
Sicyos angulatus, L. One seeded Cucumber. C.

Order 51.

CACTACEAE. CACTUS FAMILY.

OPUNTIA vulgaris, Mill. Prickly Pear. A.

Order 52.

FICOIDEAE.

SESUVIUM portulacastrum, L. Sea Purslane. E.
pentandrum, Ell. Sea Purslane. E.
MOLLUGO verticillata, L. Carpet-weed. A.

Order 53.

UMBELLIFERAE. PARSLEY FAMILY.

HYDROCOTYLE umbellata, L. Umbellate Water cup. E.
Canbyi C. & R. Canby's Water cup. E.
verticellata, Thurb. Whorled Water-cup. E.
Americana, L. American Water-cup. A.
ranunculoides, L f. Floating Water-cup. E.
Bonariensis, Lam. E.
repanda, Pers. Ovate Water-cup. E.
CRANTZIA lineata (Michx.), Nutt. Crantzia. E.
SANICULA Marylandica, L. Black Sanicle. A.
Canadensis, L. Canada Sanicle. A.
gregaria, Bicknell. Clustered Sanicle. E. and C.
ERYNGIUM yuccaefolium, Michx. Button Snake Root. A.
yuccaefolium synchaetum, Gray. Button Snake Root. E.
virgatum, Cam. Virgate Button Snake Root. A.
Virginianum, Lam. Virginia Button Snake Root. A.
praealtum, Gray. Marsh Button Snake Root.
PIMPERNELLA integerrima, B. & H. Yellow Pimpernel. E. and C.
BUPLEURUM rotundifolium, L. Hare's Ear. A.
CICUTA maculata, L. Poison Hemlock. A.
APIUM Petroselinum, L. Garden Parsley. E. and C.
graveolens, L. Celery. E. and C.
leptophyllum, D. C. Marsh Parsley. E. and C.
LEPTOCAULIS divaricatus, D. C. E.
DISCOPLEURA capillacea, D. C. Bishop weed. E.
DERINGA Canadensis, D. C. Honewort. C. and W.
SIUM lineare, Michx. Water Parsnip. A.
longifolium, Pursh. Water Parsnip. E. and C.
THASPIUM trifoliatum (L.), Britton. Golden Alexander. C. and W.
aureum, Nutt. Golden Alexander. A.
barbinode, Nutt. Hairy Golden Alexander. A.
pinnatifidum, Gray. Cut-leaved Golden Alexander. W.
LIGUSTICUM actaeifolium, Michx. Angelica. W.
ZIZIA aurea, Koch. Golden Meadow Parsnip. A.
Bebbii, C. & R. Bebb's Meadow Parsnip. W.
cordata, D. C. Heart-leaved Meadow Parsnip. A.

ANGELICA Curtissii, Buckley. Curtiss' Angelico. W.
hirsuta, Muhl. Pubescent Angelico. A.
CONIOSELINUM Canadense, T. & G. Hemlock Parsley. W.
TIEDMANIA rigida, C. & R. Water Drop-wort. E. and C.
teretifolia, D. C. Water Drop-wort. E. and C.
ternata, C. & R. Ternate Water Drop-wort. E. and C.
HERACLEUM lanatum, Michx. Cow-Parsnip. W.
DAUCUS Carota, L. Wild Carrot. A.
pusilla, Michx. Wild Carrot. A.
CHAEROPHYLLUM procumbens, Lam. Chervil. A.
Teinturieri, Hook. Chervil. E. and C.
OSMORRHIZA brevistylis, D. C. Sweet Cicely. C. & W.
longistylis, D. C, Sweet Cicely. C. and W.
ERIGENIA bulbosa, Nutt. Harbinger-of-Spring. W.
CORIANDRUM sativum, L. Coriander. C. and W.
CAUCALIS nodosa, Huds. Hedge Parsley. E.
PASTINACA sativa, L. Wild Parsnip. A.
ÆTHUSA Cynapium, L. Fool's Parsley. E.
FŒNICULUM vulgare, Gaert. Fennel. C.
SCANDIX Pecten-Veneris, L. Shepherd's-needle. E. aad C.
CARUM Carui, L. Caraway. C.

Order 54.

ARALIACEAE. GINSENG FAMILY.

ARALIA racemosa, L. Spikenard. W.
hispida Mich. Rough Sarsaparilla. W.
nudicaulis, L. Wild Sarsaparilla. W.
spinosa. Prickly Ash. A.
PANAX quinquefolium, L. Ginseng. W.
trifolium, L. Dwarf Ginseng. E.

Order 55.

CORNACEAE. DOGWOOD FAMILY.

CORNUS florida, L. Flowering Dogwood. A.
circinata, L'Her. Round-leaved Dogwood. W.
sericea, L. Swamp Dogwood, E. and C.
stolonifera, Michx. Red Osier Dogwood. W.
paniculata, L'Her. Panicled Dogwood. C. and W.
stricta, Lam. Strict Dogwood. A.
alternifolia, L. f. Alternate-leaved Dogwood. C. and W.
NYSSA sylvatica, Marsh. Tupelo. A.
biflora, Walt. Water Tupelo. E.
aquatica, L. Larger Water Tupelo. E.
Caroliniana, Poir. Carolina Tupelo. E.

Order 56.

CAPRIFOLIACEAE. HONEYSUCKLE FAMILY.

SAMBUCUS Canadensis, L. American Elder. A.
pubens, Michx. Red-berried Elder. W.

VIBURNUM alnifolium, Marsh. Hobble-bush. W.
acerifolium, L. Arrow-wood. A.
pubescens, Pursh. Downy Arrow-wood. W.
dentatum, L. Mealy-tree C. and W.
molle, Michx. Soft-leaved Arrow-wood. E.
cassinoides, L. Withe-rod. W.
nudum, L. Larger Withe-rod. A.
Lentago, L. Sheep-berry. W.
prunifolium, L. Black Haw. A.
rufotomentosum, Small. Southern Black Haw. A.
obovatum, Walt. Small Black Haw. E.
angustifolium, T. & G. Swamp Withe-rod. E.
TRIOSTEUM perfoliatum, L. Fever-wort. C. and W.
angustifolium, L. Narrow Fever-wort. C. and W.
SYMPHORICARPUS racemosus, Michx. Snow-berry. C.
vulgaris, Michx. Coral-berry. C. and W.
LONICERA Caprifolium, L. Italian Honeysuckle. C. and W.
parviflora, Lam. Glaucous Honeysuckle. W.
flava, Sims. Xellow Honeysuckle. W.
sempervirens, L. Trumpet Honeysuckle. A.
Japonica, Thumb. Japanese Honeysuckle. A.
DIERVILLA trifida, Moluch. Bush Honeysuckle. W.
sessilifolia, Buckley. Sessile-leaved Honeysuckle. W.
rivularis, Gattinger. Mountain Honeysuckle. W.

Order 57.

RUBIACEAE. MADDER FAMILY.

HOUSTONIA coerulea, L. Bluets. Innocense. A.
serphyllifolia Michx. Thyme-leaved Innocense. A.
minor (Michx.), Britton. Small Innocense. E. and C.
purpurea, L. Large Innocense. W.
purpurea pubescens, Britton. Hairy Innocense. W.
purpurea calycosa, Gray. Narrow-leaved Innocense. C. and W.
longifolia, Gaertn. Long-leaved Innocense. C.
tenuifolia, Nutt. Slender Innocense. A.
OLDENLANDIA glomerata, Michx. Clustered Bluets. E.
CEPHALANTHUS occidentalis, L. Button-bush. A.
MITCHELLA repens, L. Partridge-berry. A.
DIODIA teres, Walt. Rough Button weed. A.
Virginiana, L. Larger Button-weed. A.
GALIUM Parisiense, L. Wall Bedstraw. C.
Aparine, C. Cleavers. A.
pilosum, Ait. Hairy Cleavers. E. and C.
puncticulosum, Michx. Glabrous Cleavers. E. and C.
lanceolatum, Torr. Torrey's Cleavers. W.
circaezans, Michx. Cross Cleavers. A.
triflorum, Michx. Fragrant Cleavers. A.

GALIUM latifolium, Michx. Purple Cleavers. W.
tinctorium, L. Wild Madder. W.
tinctorium filifolium, Wie. Lesser Wild Madder. E.
Claytoni. Michx. Clayton's Madder. E.
parviflorum, Raf. Shining Madder. E. and C.
Asprellum, Michx. Rough Madder. C. and W.
hispidulum, Michx. Coast Madder. E.
trifidum, L. Small Madder. E.

Order 58.

LOGANIACEAE LOGANIA FAMILY.

SPIGELIA Marilandica, L. Pink Root. E. and C.
GELSEMIUM sempervirens, Ait. f Yellow Jessamine. E. and C.
MITREOLA petiolata, T. & G. Mitrewort. E. and C.
sessilifolia, T. & G. Whorled Mitrewort. E. and C.
POLYPREMUM procembens, L. Polypremum. A.

Order 59.

VALERIANACEAE. VALERIAN FAMILY.

VALERIANA pauciflora, Michx. Valerian. W.
VALERIANELLA Locusta, Betike. Corn Salad. C.
Chenopodifolia, D. C. Goose-foot Corn Salad. C.
radiata, Durf. Beaked Corn Salad. C.

Order 60.

DIPSACACEAE. TEASEL FAMILY.

DIPSACUS sylvestris, Miller. Teasel. C. and W.

Order 61.

CICHORIACEAE. CHICORY FAMILY.

CICHORIUM Intybus, L. Chicory. A.
divaricatum, D. C. Chicory. W.
APOGON, humilis, Ell. C.
KRIGIA Virginica, Willd. Dwarf Dandelion. A.
amplexicaulis, Nutt. Virginia Dandelion. A.
Montana, Nutt. Mountain Dandelion. W.
Dandelion, Nutt. Goat's beard. E. and C.
TRAGOPOGON porrifolius, L. Oyster Plant. E. and C.
TARAXACUM Dens leonis, Desf. Dandelion. A.
SONCHUS oleraceus, L Sow Thistle. A.
asper, All. Spiny Sow Thistle. A.
LACTUCA Canadensis, L. Wild Lettuce. A.
hirsuta, Muhl. Hairy Wild Lettuce. W.
integrifolia, Bigd. Arrow leaved Wild Lettuce. W.
acuminata, Gray. Blue Wild Lettuce. C. and W.
Floridana, Gaert. Florida Wild Lettuce. C.
leucophaea, Gray. Tall Blue Wild Lettuce. W.

LACTUCA leucophaea integrifolia, Gray. Blue Wild Lettuce. W.
graminifolia, Michx. Wild Lettuce. E.
PYRRHOPAPPUS Carolinanus, D. O. False Dandelion. A.
CREPIS pulchra, L. Hawksbeard. C.
virens, L. Smooth Hawksbeard. E.
biennis, L. Rough Hawksbeard. E.
HIERACIUM venosum, L. Bloodwort. A.
Marianum, Willd. Maryland Bloodwort. C.
Greenii, Porter & Britton. Green's Bloodwort. W.
paniculatum, L. Panicled Bloodwort. W.
scabrum, Michx. Rough Bloodwort. W.
Gronovii. L. Gronovius' Bloodwort. A.
NABALUS altissimus, Hook. Tall White Lettuce. W.
albus, Hook. Lion's-foot. A.
serpentarius, Hook. Canker-weed. W.
integrifolius, Cass. Canker weed. W.
virgatus, D. C. Slender Canker-weed. E.
crepidineus, D. C. Corymbed Canker-weed. W.

Order 62.

AMBROSIACEAE. RAGWEED FAMILY.

IVA frutescens, L. Marsh Elder. E.
imbricata, Walt. Sea-coast Marsh Elder. E.
AMBROSIA trifida, L. Great Ragweed. C. and W.
integrifolia, Muhl. Lesser Ragweed. C. and W.
artemisiafolia, L Roman Wormwood. A.
XANTHIUM spinosum, L. Clot-bur. A.
strumarium, L. Cockle-bur. A.
Canadense, Mill. American Cockle-bur. A.

Order 63.

COMPOSITAE. COMPOSITE FAMILY.

VERNONIA Noveboracensis, Willd. Iron-weed. A.
Noveboracensis tomentosa, Malt. Pubescent Iron-weed. A.
glauca (L), Britton. Broad-leaved Iron-weed. A.
gigantea (Walt.), Britton. Tall Iron-weed.
oligophylla, Michx. Naked Iron-weed. E.
angustifolia, Michx. Leafy Iron-weed. E.
ELEPHANTOPUS Carolinianus, Willd. Elephant's-foot. A.
nudatus, Gray. Smooth Elephant's-foot. A.
tomentosus, L. Woolly Elephant's-foot A.
SCLEROLEPIS verticillata, Cass. Sclerolepsis. E.
CARPHEPHORUS tomentosus, T. & G. E.
corymbosus, T. & G. E
bellidifolius, T. & G. E.
LIATRIS squarrosa, Hell. Blazing Star. E. and C.
intermedia, Small. Lesser Blazing Star. E. and C.

LIATRIS elegans, Willd. Handsome Blazing Star. E. and C.
Helleri, Small. Heller's Blazing Star. C.
scarioso, Willd. Button Snake-root. A.
squarrulosa, Michx. Small Snake-root. E. and C.
spicata, Willd. Gay Feather. E. and C.
spicata pumila, Lodd. Larger Feather. C. and W.
graminifolia, Willd. Fine-leaved Blazing Star. C. and W.
graminifolia pilosa (Ait), Britton. Ciliate Blazing Star. E.
tenuifolia, Nutt. Smooth Blazing Star. E.
pauciflora, Pursh. Pubescent Blazing Star. E.
gracilis, Pursh. Graceful Blazing Star. E.
odoratissima, Michx. Carolina Vanilla. E.
paniculata, Michx. Hairy Vanilla. E.
regimontis, Small. Vanilla C.
KUHNIA eupatoriodes, L. False Boneset. A.
EUPATORIUM purpureum, L. Queen-of-the-Meadow. A.
purpureum falcatum (Michx), Britton. Narrow-queen-of-the-Meadow. A.
purpureum amoenum, Gray. Purple Boneset. A.
foeniculaceum, Wild. Hog-weed Boneset. C.
serotinum, Michx. Late flowering Boneset. A.
leucolepis, T. & G. White-bracted Boneset. E.
album, L White Boneset. C. and W.
hyssopifolium, L. Hyssop-leaved Boneset. A.
Torreyanum, Short. Torrey's Boneset. C. and W.
semiserratum, L C. Small-flowered Boneset. E.
altissimum, L. L Tall Boneset. W.
sessilifolium, L Bastard Boneset. W.
verbenaefolium, Michx. Vervain Boneset. C. and W.
rotundifolium, L. Wild Hoarhound. C. and W.
pubescens, Muhl. Hairy Boneset. E. and C.
perfoliatum, L. Common Boneset. A
truncatum, Muhl. Traucote Boneset. A.
ageratoides, L. f. White Snake-root. C. and W.
aromaticum, L. Smaller Snake-root. C. and W.
coelestinum, L. Mist-flower. E. and C.
coronopifolium, Willd. E.
pinnatifidum, Ell. E
incarnatum, Walt. E.
MIKANIA scandens, Wild. Climbing Boneset. A.
SERICOCARPUS conyzoides, Nees. White Aster. E. and C.
solidagineus, Nees. Rough White Aster. E. and C.
tortifolius, Nees. Toothed White Aster. E. and C.
ASTER tenebrosus, Burgess. Long-leaved Wood Aster. W.
divaricatus, L. White Wood Aster. W.
divaricatus cymulosus, Burgess. W.
divaricatus curtifolius, Burgess. W.
divaricatus deltoideus, Burgess. W.

ASTER divaricatus persaliens, Burgess. W.
divaricatus fontinalis, Burgess. W.
Claytoni, Burgess. Clayton's Aster. W.
curvescens, Burgess. Dome-topped Aster. C.
curvescens umbelliformis, Burgess. C.
curvescens oviformis, Burgess. C.
Schreberi, Nees Schreber's Aster. C.
macrophyllus, L. Large-leaved Aster. W.
Shortii, Hook. Short's Aster. W.
azureus, Lindl. Sky-blue Aster. E. and C.
cordifolius, L. Common Blue Aster. E. and C.
cordifolius polycephalus, Porter. E. and C.
cordifolius alveanus, Burgess. W.
cordifolius pedicellatus, Burgess. W.
Lowrieanus, Porter. Lowrie's Aster. E. and C.
ptarmicoides Georgianas, Small. Aster. C.
undulatus, L. Wavy-leaf Aster. A.
undulatus abruptifolius, Burgess A.
undulatus loriformis, Burgess. A.
undulatus triangularis, Burgess. A.
patens, Ait. Late Purple Aster. A.
phlogifolius, Muhl. Thin-leaved Purple Aster. A.
Novae Angliae. L. New England Aster. E. and C.
oblongifolius, Nutt. Aromatic Aster. E. and C.
puniceus, L. Red-stalked Aster. A.
puniceus firmus, Nees. Red-stalked Aster. A.
laevis, L. Smooth Aster. E. and C.
concinus, Willd. Narrow-leaved Smooth Aster. E.
purpuratus, Nees. Southern Smooth Aster. E.
Novi-Belgii elodes, T. & G. Aster. E.
Novi-Belgii Atlanticus, Burgess. Atlantic Aster. E.
Novi Belgii Brittonii, Burgess. Britton's Aster. E.
concolor, L. Eastern Silvery Aster. E.
grandiflorus, L. Large flowered Aster. E. and C.
surculosus, Michx. Creeping Aster. E. and C.
gracilis, Nutt. Tuber Aster. A.
acuminatus, Mich. Mountain Aster W.
dumosus, L. Bushy Aster. E. and C.
cordifolius, T. & G. Stouter Bushy Aster. E.
paniculatus, Lam. Panicled Aster. C.
bellidiflorus, Willd. Aster. C. and W.
simplex, Willd. Aster. C. and W.
Tradescanti, L. Tradescant's Aster. C.
Faxoni, Porter. Faxon's Aster. W.
ericoides, L Frost weed Aster. E. and C.
ericoides pilosus, Porter. Aster. W.
ericoides platyphyllus, T. & G. Aster. W.
lateriflorus (L.), Britton. Calico Aster. E.

ASTER lateriflorus glomerellus, Burgess. Aster. E.
lateriflorus pendulus, Burgess. Aster. E.
lateriflorus horizontalis, Burgess. Aster. E.
vimineus, Lam. Small White Aster. C.
foliolosus, Ait. Aster. C.
multiflorus, L. White Wreath Aster. A.
tenuifolius L. Perennial Aster. E.
subulatus, Michx. Annual Aster. E.
spectabilis, Ait. Seaside Purple Aster. E.
Curtissii, T. & G. Curtiss' Aster. W.
squarrosus, Walt. Aster. E.
Elliottii, T. & G. Elliott's Aster. E. and C.
infirmus, Michx. Cornel-leaved Aster. W.
umbellatus, Willd. Tall Flat-top Aster. C.
amygdalinus, T. & G. Broad Flat-top Aster. C.
linarifolius, L. Savory-leaved Aster. E and C.
ERIGERON strigosus, Muhl. Daisy Fleabane. A.
annuus. Pers. Sweet Scabious. A.
Philadelphicus, Muhl. Philadelphia Fleabane. A.
bellidifolius, Muhl. Plantain Fleabane. E. and C.
nudicaulis, Michx. Early Fleabane. E. and C.
Canadensis, L. Canada Fleabone. A.
linifolius, Willd. Panicled Fleabane. A.
BOLTONIA diffusa, Ell. Panicled Boltonia. E.
glastifolia, L'Her. Boltonia. E.
asteroides, L'Her. Aster-like Boltonia. A.
BELLIS perrenis, L. European Daisy. E.
SOLIDAGO squarrosa, Muhl. Stout Ragged Golden rod. A.
petiolaris, Ait. Downy Ragged Golden-rod. W.
caesia, L. Blue-stemmed Golden-rod. E. and C.
flexicaulis, L. Zig-zag Golden-rod. E. and C.
Curtissii, T. & G. Curtis' Golden rod. W.
bicolor, L. White Golden-rod. W.
uliginosa, Nutt. Golden rod. W.
hispida, Muhl. Hairy Golden-rod. W.
erecta, Pursh. Slender Golden-rod. A.
monticola, T. & G. Mountain Golden-rod. W.
puberula, Nutt. Downy Golden-rod. E.
stricta, Ait. Wand-like Golden-rod. E.
speciosa, Nutt. Noble Golden-rod. A.
Purshii, Porter. River-bank Golden-rod. E.
sempervirens, L. Sea-side Golden-rod. E.
odora, Ait. Sweet Golden-rod. A.
odora inodora, Gray. Scentless Golden-rod. A.
tortifolia, Ell. Twisted-leaf Golden-rod. E. and C.
rugosa, Mill. Wrinkle-leaved Golden-rod. A.
fistulosa, Mill. Pine-barren Golden-rod. E.
patula, Muhl. Spreading Golden-rod. C. and W.

SOLIDAGO patula strictula, T. & G. Strict Spreading Golden-rod. C. and W.
ulmifolia, Muhl. Elm leaved Golden-rod. C. and W.
Boottii, Hook. Boot's Golden-rod. C. and W.
Boottii Yadkinensis, Britton. Yadkin Golden-rod. C.
Elliottii, T. & G. Elliott's Golden-rod. E.
juncea, Ait Sharp toothed Golden-rod. A.
arguta, Ait Cut leaved Golden-rod. W.
serotina, Ait. Late Golden-rod. W.
gigantia, Ait. Hispid Late Golden-rod. W.
Canadensis, L. Canada Golden-rod. C.
Canadensis scabriuscula, Porter. Golden-rod. C.
nemoralis, Ait. Field Golden rod. C.
rigida, L Hard leaved Golden rod. A.
graminifolia, Ell. Fragrant Golden-rod. C.
tenuifolia, Pursh. Slender Fragrant Golden-rod. C.
sphacelata, Raf. False Golden-rod. W.
pubens, Curtis. Pubescent Golden rod W.
Buckleyi, T. & G. Buckley's Golden-rod. W.
lancifolia, T. & G. Mountain Golden-rod. W.
pulverulenta, Nutt. Pine-barren Golden-rod. E.
verna, Curtis. Hoary Pine-barren Golden rod. E.
glomerata, Michx. High Mountain Golden rod. W.
spithamaea, Curtis. Tufted stemmed Golden-rod. W.
angustifolia, Ell. Sea coast Golden-rod. E.
amplexicaulis, T. & G. Clasping Golden-rod. C.
plumosa, Small. C.

BIGELOVIA nudata, D. C. Rayless Golden-rod. E.

CHRYSOPSIS graminifolia, Nutt. Golden Aster. E.
Mariana, Nutt. Maryland Golden Aster. A.
trichophylla, Nutt. Biennial Golden Aster. E.
hyssopifolia, Nutt. Hissop-like Golden Aster. E.
gossypina, Nutt. Cottony Golden Aster. E.

BACCHARIS halemifolia, L. Groundsel-bush. E.
glomerulifolia, Pers. Groundsel bush. E.
angustifolia, Michx. Groundsel-bush. E.

INULA Helenium, L. Elecampane. W.

PLUCHEA bifrons, D C. Viscid Marsh Fleabane. E. and C.
foetida, D. C. Inland Marsh Fleabane. E. and C.
camphorata, D. C. Spicy Marsh Fleabane. E. and C.

PTEROCAULON pycnostachyum, Ell Pterocaulon. E.

ANTENNARIA margaritacea, R Br. Everlasting. A.
plantaginifolia, Hook. Plantain Everlasting. A.
neodioica, Greene. Cat's foot Everlasting. C.
neglecta, Greene. Field Cat's-foot Everlasting. C.

GRAPHALIUM polycephalum, Michx. Sweet Life Everlasting. A.
Helleri, Britton. Heller's Life Everlasting. E. and C.
purpureum, L. Purple Life Everlasting. A.

GRAPHALIUM uliginosum, L. Low Marsh Life Everlasting. E.
FIALGO Germanica, L. Cudweed. C.
POLYMNIA Canadensis, L. Mountain Cup-plant. W.
Uvedalia, L. Indian Cup-plant. A.
ACANTHOSPERMUM xanthioides D. C. A.
CHRYSOGONUM Virginianum, L. Chrysogonum. A.
SILPHIUM compositum, Michx. Rosin-weed. C.
trifoliatum, L. Whorled Rosin weed. A.
Astericus, L. Starry Rosin weed. E.
Astericus dentatum. Rosin weed. E
perfoliatum, L. Indian-cup. A.
BERLANDIERA tomentosa, Nutt. Berlandiera. E.
PARTHENIUM integrifolium, L. Cutting Almond. A.
auriculatum, Britton. Auricled Cutting Almond. W.
ECLIPTA alba, Hassk. Eclipta. E. and C.
BORRICHIA frutescens, D. C. Sea Ox-eye. E.
ZINNIA pauciflora, L. Zinnia. E.
HELIOPSIS laevis, Pers. False Sun-flower. C.
gracilis, Nutt. Slender False Sun flower. C.
TETRAGONOTHECA helianthoides, L. Tetragonotheca. A.
SPILANTHES repens, Michx. Spilanthes. C.
ECHINACEA purpurea, Moench. Purple Cone-flower. C.
RUDBECKIA triloba, L. Thin-leaved Cone-flower. E. and C.
hirta, L. Black Eyed Susan. A.
Brittonii, Small. Britton's Cone-flower. W.
fulgida, Ait. Orange Cone-flower. W.
spathulata, Michx. Flat-headed Cone-flower. C.
laciniata, L. Thimble.weed. A.
laciniata humilis, Gray. Thimble-weed. A.
speciosa, Neud. Cone-flower. C.
rupestris, Gray. Cone flower. W.
pinnatiloba, T. & G. Cone-flower. W.
LEPACHYS pinnata, T. & G. Gray-headed Cone flower. A.
HELIANTHUS angustifolius, L. Swamp Sun-flower. E.
annuus, L. Common Sun-flower. A.
atrorubens, L Purple-dish Sun flower. A.
laevigatus, T. & G. Smooth Sun-flower. W.
parviflorus, Bernh. Small Wood Sun-flower. C. and W.
giganteus, L. Giant Sun-flower. W.
divaricatus, L. Cough Sun-flower. W.
strumosus, L. Pale Wood Sun-flower. W.
hirsutus, Raf. Stiff-haired Sun-flower. W.
glaucus, Small. Glaucous Sun-flower. C.
tomentosus, Michx. Woolly Sun-flower. A.
tuberosus, L. Jerusalem Artichoke. A.
heterophyllus, Nutt. Sun-flower. E.
occidentalis (Ridd.) Dowellianus, T. & G. Sun-flower. W.

HELIANTHUS decapetalus, L. Sun-flower. W.
Schweinitzii, T. & G. Sun-flower. W.
VERBESINA Virginica, L. Virginia Crownbeard. A.
occidentalis, Walt. Small Yellow Crownbeard. A.
ACTINOMERIS squarrosa, Nutt. Actinomeris. A.
COREOPSIS discoidea, T. & G. Swamp Tickseed.
rosea, Nutt. Small Rose Tickseed. E.
senifolia, Michx. Greater Tickseed. A.
senifolia stellata, T. & G. Stellate Tickseed. A.
delphinifolia, Lam. Larkspur Tickseed, C.
longifolia, Small. Tickseed. E. and C.
verticillata, L. Whorled Tickseed. A.
lanceolata, L. Lance-leaved Tickseed. E.
pubescens, Ell. Star Tickseed. C. and W.
crassifolia, Ait. Hairy Tickseed. C.
auriculata, L Running Tickseed. A.
tripteris, L. Tall Tickseed. A.
aurea, Ait. Showy Tickseed. E.
trichosperma, Michx. Smooth Tickseed. E. and C.
latifolia, Michx. Mountain Tickseed. W.
gladiata, Walt. Terete Tickseed. E.
angustifolia, Ait. Branching Tickseed. E.
BIDENS frondosa, L. Beggar's-ticks. A.
cernua, L. Smaller Beggar's-ticks. A.
chrysanthemoides, Michx. Brook Beggar's-ticks. A.
bipinnata, L. Spanish-needle Beggar's-ticks. A.
connata, Muhl. Purple-stemmed Beggar's-tick. A.
discordea, T. & G. Swamp Beggar's-ticks. E. and C.
BALDWINIA uniflora, Ell. Baldwinia. E
GALINSOGA parviflora, Cav. Galinsoga. A.
parviflora hispida, D. C. Galinsoga. A.
MARSHALLIA latifolia, Pursh. Marshallia. A.
lanceolata, Pursh. Lance-leaved Marshallia. A.
lanceolata platyphylla, Curtis. Marshallia. A.
lacinarioides, Small. Marshallia. E.
angustifolia, Pursh. Marshallia. E.
HELENIUM autumnale, L. Sneezeweed. A.
nudiflorum, Nutt. Purple-head Sneezeweed. A.
tenuifolium, Nutt. Fine-leaved Sneezeweed. A.
quadridentatum, Labill. Sneezeweed. W.
vernale, Walt. Sneezeweed. E
Curtissii, Gray. Curtis' Sneezeweed. E. and C.
ACHILLEA millefolium, L. Yarrow. A.
ANTHEMIS Cotula, L. May-weed. A.
arvensis, L. Field Camomile. E. and C.
nobilis, L. Garden Camomile. E. and C.
tinctoria, L. Ox-eye Camomile. E. and C.
CHRYSANTHEMUM Leucanthemum, L. Ox-eye Daisy. A.
Parthenium, Pers. Feverfew. C.

TANACETUM vulgare, L. Tausy. A.
vulgare crispum, D. C. Tausy. A.
ARTEMISIA caudata, Mich. Wild Wormwood. E.
Abrotanum, L. Southernwood. C.
vulgaris, L. Mugwort. C.
ARNICA nudicaulis, Nutt. Leopard's-bane. E. and C.
ERECHTITES hieracifolia, Raf. Fire-weed. A.
CACALIA reniformis, Muhl. Indian Plantain. W.
atriplicifolia, L. Pale Indian Plantain. A.
suaveolens, L. Wild Caraway. A.
SENECIO tomentosus, Michx. Wooly Ragweed. A.
obovatus, Muhl. Round-leaf Ragweed. E. and C.
Balsamitae, Muhl. Balsam Ragweed. W.
Smallii, Britton. Small's Ragweed. W.
Robbinsii, Oakes. Robbins' Ragweed. W.
aureus, L. Life-root. A.
gracilis, Pursh. Slender Life-root. E.
lobatus, Pers. Butter-weed. A.
vulgaris, L. Groundsel. C.
viscosus, L. Fetid Groundsel. E.
Millefolium, T. & G. Mountain Groundsel. W.
ARCTIUM Lappa, L. Burdock. A.
minus, Schk. Common Burdock. W.
CARDUUS lanceolatus, L. Spear Thistle. A.
altissimus, L. Roadside Thistle. A.
discolor, Nutt. Field Thistle. A.
Virginianus, L Virginia Thistle. A.
horridulus, Pursh. Yellow Thistle. E.
muticus, Pers. Swamp Thistle. E.
arvensis, Robs. Canada Thistle. E. and C.
repandus, Ell. Pine-barren Thistle. E.
CENTAUREA Cyanus, L. Corn-flower. A.
Calcitrapa, L. Star Thistle. E.
CNICUS benedictus, L. Blessed Thistle. E.
CHAPTALIA tomentosa, Vent. Chaptalia. E.

Order 64.

LOBELIACEAE. LOBELIA FAMILY.

LOBELIA cardinalis, L. Cardinal Flower. A.
syphilitica, L. Great Blue Lobelia. C. and W.
puberula, Michx. Downy Lobelia. E. and C.
leptostachys, A. D. C. Spiked Lobelia. W.
amoena, Michx. Southern Lobelia. E. and C.
amoena glandulifera. Gray Lobelia. E. and E.
glandulosa, Walt. Glandular Lobelia. A.
inflata, L. Tobacco Lobelia. C. and W.
spicata, Lam. Pale Spiked Lobelia. C. and W.
Nuttallii, R. & S. Nuttall's Lobelia. E. and C.

LOBELIA paludosa, Nutt. Swamp Lobelia. E.
Canbyi, Gray. Canby's Lobelia. E and C.
Cliffortiana, Gray. Clifford's Lobelia. E.

Order 65.

CAMPANULACEAE. CAMPANULA FAMILY.

CAMPANULA aparinoides, Pursh. Bell flower. W.
divaricata, Michx. Panicled Bell flower. W.
Americana, L. Tall Bell flower. W.
SPECULARIA perfoliata, D. C. Large Venus' Looking-glass. A.
biflora, Gray. Small Venus' Looking-glass. A.

Order 66.

CLETHRACEAE. WHITE ALDER FAMILY.

CLETHRA alnifolia, L. Sweet Pepper bush. C. and W.
acuminata, Michx. Mountain Pepper bush. W.

Order 67.

PYROLACEAE. WINTERGREEN FAMILY.

PYROLA rotundifolia, L. Canker Lettuce. W.
CHIMAPHYLLA maculata, Pursh. Wintergreen. A.
umbellata, Nutt. Fragrant Wintergreen. W.

Order 68.

MONOTROPACEAE. INDIAN PIPE FAMILY.

MONOTROPSIS ordorata, Ell. Sweet Pine-sap. E.
MONOTROPA uniflora, L. Indian Pipe. A.
Hypopitys, L. False Beech-drops. A.

Order 69.

ERICACEAE. HEATH FAMILY.

AZALEA nudiflora, L. Pink Azalea. A.
canescens, Michx. Mountain Azalea. W.
calendulacea, Michx. Flame Azalea. C. and W.
arborescens, Pursh. Fragrant Azalea. C. and W.
viscosa, L. White Azalea. C. and W.
glauca, Michx. Glaucous. White Azalea. W.
nitida, (Pursh) Britton. Shrubby. White Azalea. W.
RHODODENDRON maximum, L. Great Laurel. W.
Catawbiense, Michx. Catawba Laurel. W.
Vaseyi, Gray. Vasey's Laurel. W.
punctatum, Andr. Rose Laurel. W.
MENZEISIA globularis, Salisb. Menzeisia. W.
LEIOPHYLLUM buxifolium, Ell. Sand Myrtle. E. & W.
prostrtum. W.
KALMIA latifolia, L. Mountain Laurel. C. and W.
angustifolia. Sheep Laurel. E. and C.

KALMIA cuneata. Michx. Swamp Laurel. E.
hirsuta, Walt. Hairy Laurel. E.
LEUCOTHOE axillaris, Don. Downy Leucothoe. E.
Catesbaei, Gray. Catesby's Leucothoe. C. and W.
recurva, Gray. Mountain Leucothoe. W.
racemosa, Gray. Swamp Leucothoe. A.
ANDROMEDA floribunda, Pursh. Fetter-bush. W.
nitida, Bartr. Common Fetter-bush. A.
Mariana, L. Stagger-bush. E. and C.
ligustrina, Muhl. False Privet. C. and W.
pubescens. Small Privet. W.
speciosa, Michx. Pine-barren Privett. E.
pulverentula, (Michx.) Ashe. E. and C.
CASSANDRA calyculata, Don. Cassaudra. W.
OXYDENDRUM arboreum, D. C. Sour-wood. A.
EPIGAEA repens, L. Trailing Arbutus. A.
GAULTHERIA procumbens, L. Checker-berry. W.

Order 70.

VACCINIACEAE. HUCKLE BERRY FAMILY.

GAYLUSSACIA frondosa, T. and G. Tangle berry. E. and C.
dumosa, T. and G. Bush Tangle-berry. E. and C.
hirtella, Gray. Hairy Bush Tangle-berry. E.
resinosa, T. and G. Black Tangle berry. E. and C.
ursina, Gray. Taller Black Tangle-berry. W.
brachycera, Gray. Glabrous Black Tangle-berry. W.
VACCINIUM virgatum, Ait. Southern Black Huckleberry. A.
tenellum, Ait. Lesser Black Huckleberry. E.
corymbosum. L. High-bush Huckleberry. A.
fuscatum. Gray Huckleberry. E.
pallidum, Ait. Mountain Huckleberry. W.
vacillans, Kalm. Low Blue Huckleberry. W.
stamineum, L. Deerberry. A.
arboreum, Marsh. Farkleberry. E.
crassifolium, Andr. Eastern Black Huckleberry. E.
myrsinites, Michx. Huckleberry. E.
hirsutum, Buckley. Hairy Huckleberry. W.
CHIOGENES hispidula, T. and G. Snowberry. W.
OXYCOCCUS macrocarpus, Pers. American Cranberry. E. and W.
erythrocarpus, Pers. Mountain Cranberry. W.

Order 71.

DIAPENSIACEAE. DIAPENSIA FAMILY.

PYXIDANTHERA barbulata, Michx. Flowering Pyxie. E.
GALAX aphylla, L. Galax. C. and W.
SHORTIA galacifolia, Gray. "Hyams' Sparkling Shortia." W.

Order 72.

STYRACACEAE. STORAX FAMILY.

STYRAX pulverulenta, Michx. Downy Storax. E.
grandiflora, Ait. Large-leaved Storax. A.
Americana, Lam. Smooth Storax. A.
HALESIA diptera, L. Snowdrop Tree. W.
tetraptera, L. Snowdrop Tree. C. and W.

Order 73.

SYMPLOCACEAE. SWEET-LEAF FAMILY.

SYMPLOCUS tinctoria, L'Her. Horse-sugar. C. and W.

Order 74.

EBENACEAE. EBONY FAMILY.

DIOSPYROS Virginiana, L. Persimmon. A.

Order 75.

SAPOTACEAE. SAPODILLA FAMILY.

BUMELIA lycioides, Pers. Buckthorn. C.

Order 76.

PRIMULACEAE. PRIMROSE FAMILY.

HOTTONIA inflata, Ell. Featherfoil. E.
SAMOLUS floribundus, H. B. K. Brookweed. E.
LYSIMACHIA quadrifolia, L. Whorled Loosestrife. C. and W.
stricta, Ait. Bulb-bearing Loosestrife. E.
Fraseri, Duby. Fraser's Loosestrife. W.
asperulaefolia, Poir. Loosestrife.
STEIRONEMA ciliatum, Raf. Fringed Loosestrife. A.
tonsum, Bicknell. Southern Loosestrife. W.
radicans, Gray. Trailing Loosestrife. C.
lanceolatum, Gray. Lance-leaved Loosestrife. E. and C.
ANAGALLIS arvensis, L. Red Pimpernel W.
DODECATHEON Meadia, L. American Cowship. E. and C.
CENTUNCULUS minimus, L. Chaff-weed. E.

Order 77.

PLUMBAGINACEAE. LEADWORT FAMILY.

STATICE Caroliniana, Walt Marsh Rosemary. E.
Brasiliensis, Boissier. Rosemary. E.

Order 78.

LENTIBULACEAE. BLADDERWORT FAMILY.

UTRICULARIA cornuto, Michx. Horned Bladderwort. E. and C.
juncea, Vahl. Rush Bladderwort. E. and C.
resupinata, Greene. Reversed Bladderwort. E. and C.

UTRICULARIA subulata, L. Zig zag Bladderwort. E. and C.
inflata, Walt. Swollen Bladderwort. E. and C.
purpurea, Walt. Purple Bladderwort. E. and C.
vulgaris, L. Greater Bladderwort. E. and C.
fibrosa, Walt. Fibrous Bladderwort. E.
gibba, L. Humped Bladderwort. E. and C.
PINGUICULA lutea, Walt Butterwort. E.
elatior, Michx. Purple Butterwort. E. and C.

Order 79.

BIGNONIACEAE. BIGNONIA FAMILY.

BIGNONIA capreolata, L. Cross vine. A.
TECOMA radicans, Juss. Trumpet flower. A.
CATALPA bignonioides, Walt. Catawba Tree. C.
cordifolia, Moench. Catawba Tree. W.

Order 80.

MARTYNICACEAE. UNICORN-PLANT FAMILY.

MARTYNIA Louisiana, Will. Unicorn-Plant. A.

Order 81.

OROBANCHACEAE. BROOM RAPE FAMILY.

EPIPHEGUS Virginiana, Bart. Beech-drops. A.
CONOPHOLIS Americana, Wallr. Squaw-root A.
APHYLLON uniflorum, T. & G Cancer-root. A.

Order 82.

SCROPHULARIACEAE. FIGWORT FAMILY.

VERBASCUM Thapsus, L. Great Mullein. A.
Lychnitis, L. White Mullein. A.
Blattaria, L. Moth Mullein. A.
LINARIA Cymbalari, Mill. Coliseum Ivy. E.
spuria, Mill. Round leaved Toad-Flax. E.
Elatina, Mill. Cancerwort Toad-Flax. E.
vulgaris, Mill. Yellow Toad-Flax. A.
Canadensis, Dumont. Blue Toad-Flax. A.
repens, Mill. Pale Blue Toad-Flax. E.
ANTIRRHINUM majus, L. Lion's mouth E.
SCROPHULARIA Marylandica, L. Figwort. C. and W.
leporella, Bicknell. Hare Figwort. W.
CHELONE glabra, L. Snake head. A.
obliqua. L. Red Turtle-head. C.
Lyoni, Pursh. Lyon's Turtle head. W.
PENSTEMON pubescens, Soland. Hairy Beard-tongue. C and W.
canescens, Britton. Gray Beard-tongue. C. and W.
Digitalis, Nutt. Foxglove Beard-tongue. C.
laevigatus, Soland. Smooth Beard-tongue. C. and W.

PAULOWNIA imperialis, Sieb. Paulownia. C. and W.
MIMULUS ringens, L. Monkey-flower. A.
alatus, Soland. Winged Monkey-flower. E. and C.
HERPESTRIS Monniera, H. B. K. Hedge-Hyssop. E.
nigrescens, Benth. Purple Hedge-Hyssop. C.
amplexicaulis, Pursh. Blue Hedge-Hyssop. E.
GRATIOLA Virginiana, L. Clammy Hedge-Hyssop. C. and W.
sphaerocarpa, Ell. Round-fruited Hedge Hyssop. A.
aurea, Muhl. Golden Hedge-Hyssop. E.
viscosa, Schwein. Viscid Hedge-Hyssop. W.
Drummondi, Benth. Drummond's Hedge-Hyssop. W.
officinalis, L. Hedge-Hyssop. C.
pilosa, Michx. Hairy Hedge-Hyssop. E.
ILYSANTHES gratioloides, Benth. False Pimpernel. E.
attenuata (Muhl), Small. False Pimpernel. W.
saxicola, Chapm. False Pimpernel. W.
MICRANTHEMUM Nuttallii, Gray. Nuttall's Micranthemum. E.
orbiculatum, Michx. Micranthemum. E.
VERONICA Anagallis, L Speedwell. C. and W.
Anagallis aquatica, L. Water Speedwell. E.
officinalis, L. Common Speedwell. C. and W.
serpyllifolia, L. Thyme leaved Speedwell. W.
peregrina, L. Purslane Speedwell. W.
arvensis, L. Corn Speedwell. A.
agrestis, L Garden Speedwell. C.
LEPTANDRA Virginica, Nutt. Culver's root. C. and W.
DIGITALIS purpurea. L. Purple Fox-glove. C.
BUCHNERA Americana, L. Blue-hearts. C.
SEYMERIA tenuifolia, Pursh. Mullein Fox-glove. C. and W.
macrophylla, Nutt. Mullein Fox-glove. W.
OTOPHYLLA Michauxii, Benth. Michaux's Fox-glove. E.
DASYTOMA Pedicularia, Benth. Lousewort Fox glove. A.
flava, Wood. Downy Fox-glove. A.
laevigata, Raf. Entire-leaved Fox glove. A.
quercifolia, Benth. Smooth Fox glove. E. and C.
pectinata, Benth. Villions Fox-glove. E.
GERARDIA linifolia, Nutt. Flax leaved Gerardia. E.
purpurea, L Large Purple Gerardia. A.
purpurea fasciculata, Chapm. Purple Gerardia. E.
maritima, Raf. Sea-side Gerardia. E
tenuifolia, Vahl. Slender Gerardia. A
tenuifolia filiformis, Chapm. Filiform Gerardia. A.
Skinneriana, Wood. Skinner's Gerardia. E.
auriculata, Michx. Auricled Gerardia. E. and C.
aphylla, Nutt. Pine-barren Gerardia. E.
setacea, Walt. Setaceous, Gerardia. C.
CASTILLIJA coccinea, Spreng. Painted-cup. C. and W.
SCHWALBEA Americana, L. Chaff-seed. E.

PEDICULARIS lanceolata, Michx. Swamp Lousewort. W.
Canadensis, L. Betony Lousewort. A.
MELAMPYRUM lineare, Lam. Cow-wheat. W.
latifolium, Muhl. Cow-wheat. W.

Order 83.

SOLANACEAE. NIGHTSHADE FAMILY.

ATROPA physalodes, L. Apple-of Peru. C. and W.
PHYSALIS pubescens, L. Low Hairy Ground Cherry. A.
Barbadensis, Jacq. Barbadoes Ground Cherry. A.
obscura, Michx. Glabrous Ground Cherry. A.
angulata, L. Cut-leaved Ground Cherry. C.
Philadelphica, Lam. Philadelphia Ground Cherry. C.
lanceolata, Michx. Prairie Ground Cherry. W.
Virginiana, Mill. Virginia Ground Cherry. A.
heterophylla, Nees. Clammy Ground Cherry. C.
heterophylla nyctagina, Rydberg. Clammy Ground Cherry. C.
viscosa, L. Stellate Ground Cherry. E.
SOLANUM nigrum, L. Black Nightshade. A.
Carolinense, L. Horse Nettle. A.
Dulcamara, L. Woody Nightshade. W.
Lycopersicum, L. Love Apple. C.
aculeatissimum, Jacq. Nightshade. C.
LYCIUM vulgare, Dunal. Box-thorn. C.
Carolinianum, Michx. E.
DATURA Stramonium, L. Jamestown-weed. A.
Tatula, L. Purple Jamestown-weed. A.
Metel, L. Entire-leaved Jamestown-weed. E.
NICOTIANA rustica, L. Wild Tobacco. C.

Order 84.

CONVOLVULACEAE. MORNING GLORY FAMILY.

DICHONDRA repens, Forst. Dichondra. E.
BREWERIA humistrata, (Walt) Gray. Breweria. E.
aquatica, (Walt) Gray. Water Breweria. E.
Pickeringii, (Curtis) Gray. Pickering's Breweria. E.
IPOMOEA Quamoclit, L. American Red Bell-flower. E. and C.
coccinea, L. Small Red Morning glory. A.
pandurata, (L.) Meyer. Wild Potato Vine. A.
lacunosa, L. Small White Morning-glory. A.
Carolina, (L.) Pursh. Small Pink Morning-glory. E.
purpurea, (L.) Roth. Purple Morning-glory. A.
hederacea, Jacq. Ivey-leaved Morning-glory. A.
sagittata, Cav. Sagitate Morning glory. E.
tamnifolia, Griseb. Bracted Morning-glory. E.
CONVOLVULUS sepium, L. Hedge Bindweed. A.
repens, L. Trailing Bindweed. A.

CONVOLVULUS spithamaeus, L. Upright Bindweed. W.
arvensis L. Small Bindweed. A.

Order 85.

CUSCUTACEAE. DODDER FAMILY.

CUSCUTA arvensis, Beyrich. Field Dodder. A.
indecora, Choisy. Pretty Dodder. A.
Coryli, Engelm. Hazel Dodder. W.
Gronovii, Willd. Love-vine Dodder. A.
rostrata, Shuttlw. Beaked Dodder. W.
compacta, Juss. Compact Dodder. C.
inflexa, Engelm. Umbel Dodder. E. and C.

Order 86.

POLEMONIACEAE. PHLOX FAMILY.

PHLOX paniculata, L. Garden Phlox. A.
maculata, L. Wild Sweet William. C. and W.
ovata, L. Mountain Phlox. W.
glaberrima, L. Smooth Phlox. W.
glaberrima suffruticosa, Gray. Smooth Scabrous Phlox. W.
reptans, Michx. Crawling Phlox. E.
divaricata, L. Wild Blue Phlox. A.
amoena, Sims. Hairy Phlox. C.
pilosa, L. Downy Phlox. C.
subulata, L. Moss Pink Phlox. E.
Drummondii, Hook. Drummond's Phlox. A.
POLEMONIUM reptans, L. Greek Valerian. W.

Order 87.

GENTIANACEAE. GENTIAN FAMILY.

SABBATIA lanceolata, (Walt) T. and G. Lance-leaved Sabbatia. E.
paniculata, (Michx) Pursh. Branching Sabbatia. E.
angustifolia, (Michx) Britton. Narrow-leaved Sabbatia. E.
angularis, (L) Pursh. Square-stemmed Sabbatia. A.
calycina, (Lam) Heller. Coast Sabbatia. E.
stellaris, Pursh. Marsh Sabbatia. E.
Elliottii, Steud. Elliott's Sabbatia. E. and C.
gracilis, Salisb. Slender Marsh Sabbatia. E.
chloroides, Pursh. Large Marsh Sabbatia. E.
GENTIANA quinqueflora, Lam. Stiff Gentian. W.
crinita, Froel. Fringed Gentian. W.
ochroleuca, Froel. Striped Gentian. E. and C.
Elliottii, Chapm. Elliott's Gentian. E and C.
Saponaria, L. Soapwort Gentian. A.
Andrewsii, Griseb. Closed Gentian. W.
flavida, Gray. Yellowish Gentian. E.
angustifolia, Michx. One-flowered Gentian. E.

FRASERA Carolinensis, Walt. American Columbo. A.
OBOLARIA Virginica, L. Pennywort. C.
BARTONIA Virginica, (L.) B. S. P. Yellow Bartonia. E.
verna, (Michx.) Muhl. White Bartonia. E.

Order 88.

MENYANTHACEAE. BUCKBEAN FAMILY.

LIMNANTHEMUM lacunosum (Vent), Griseb. Floating Heart. E.
aquaticum (Walt), Britton. Larger Floating Heart. E.

Order 89.

APOCYNACEAE. DOGBANE FAMILY.

AMSONIA Tabernaemontana, Walt. Amsonia. C. and W.
ciliata, Walt. Pale Amsonia. C. and W.
VINCA minor, L. Small Periwinkle. A.
major. Large Periwinkle. A.
APOCYNUM androsaemifolium, L. Bitter-root. A.
cannabinum, L Indian Hemp. A
cannabinum glaberrimum, D. C. Glabrous Hemp. A.
ECHITIS difformis, Walt. Echites. C.

Order 90.

ASCLEPIADACEAE. MILKWEED FAMILY.

ASCLEPIAS tuberosa, L. Butter-fly Weed. A.
decumbens, L. Decumbent Butter-fly Weed. A.
lanceolata, Walt. Few flowered Milkweed. E.
rubra, L. Red Milkweed. E. and C.
laurifolia, Michx. Red Milkweed. W.
purpurascens, L. Purple Milkweed. W.
incarnata, L. Swamp Milkweed. A.
pulchra, Ehrh. Hairy Milkweed. A.
obtusifolia, Michx. Blunt-leaved Milkweed. A.
exaltata (L.), Muhl. Tall Milkweed. W.
variegata, L. White Milkweed. A.
quadrifolia, Jacq. Four leaved Milkweed. C. and W.
Syriaca, L. Common Milkweed. A.
perennis, Walt. Thin-leaved Milkweed. C.
verticillata, L. Whorled Milkweed. A.
amplexicaulis, Michx. Clasping Milkweed. E.
tomentosa, Ell. Villous Milkweed. E.
ACERATES viridiflora (Raf.), Eaton. Green Milkweed. A.
viridiflora Ivesii, Britton. Ives' Milkweed. A.
longifolia, Ell. Florida Milkweed. E. and C.
PODOSTIGMA pubescens, Ell. Podostigma. E.
SENTERA maritima Decaisne. Sentera. E.

GONOBOLUS macrophyllus, Michx. Large-leaved Negro-vine. C. and W.
suberosus, R. Br. Coast Negro vine. E.
hirsutus, Michx. Hairy Negro-vine. A.
obliquus, R. Br. Large flowered Negro-vine. E. and C.
Carolinensis, R. Br. Carolina Negro-vine. A.

Order 91.

OLEACEAE. OLIVE FAMILY.

SYRINGA vulgaris, L Lilac. C.
OSMANTHUS Americanus, B. & H. Osmanthus. E.
CHIONANTHUS Virginica, L. Fringe Tree. A.
FRAXINUS Americana, L. White Ash. A.
viridis, Michx, Green Ash. E. and C.
pubescens, Lam. Marsh Red Ash. C.
platycarpa, Michx. Water Ash. E.
nigra, Marsh. Black Ash. E.
Biltmoreana, Beadll. Biltmore Ash. W.

Order 92.

HYDROPHYLLACEAE. WATER-LEAF FAMILY.

HYDROPHYLLUM Virginicum, L. Virginia Water-leaf. W.
macrophyllum, Nutt. Large-leaved Water-leaf. W.
Canadense, L. Broad-leaved Water-leaf. W.
appendiculatum, Michx. Appendaged Water-leaf. W.
NEMOPHILA microcalyx, Nutt. Nemophila.
PHACELIA bipinnatifida, Michx. Loose-flowered Phacelia. W.
parviflora, Pursh. Small flowered Phacelia. W.
hirsuta, Nutt. Hairy Phacelia. W.
Purshii, Buckl. Pursh's Phacelia. W.
fimbriata, Michx. Fringed Phacelia. W.
HYDROLEA quadrivalvis, Walt. Hairy Hydrolea. E.

Order 93.

BORAGINACEAE. BORAGE FAMILY.

HELIOTROPIUM Europaeum, L. European Heliotrope. C.
Curassavicum. L. Sea-side Heliotrope. E.
Indicum, F. Indian Heliotrope. E. and C.
anchusaefolium, Poir. Heliotrope. E. and C.
CYNOGLOSSUM officinale, L. Hound's-tongue. W.
Virginicum, L L. Wild Comfrey. W.
LAPPULA Virginiana (L.), Greene. Virginia Stickseed. W.
MERTENSIA Virginica (L.), D. C. Virginia Cowslip. A.
MYOSOTIS laxa, Lehm. Forget-me-not. W.
Virginica (L.), B. S. P. Spring Scorpion-grass. C.
LITHOSPERMUM arvense, L. Corn Gromwell. A.

LITHOSPERMUM latifolium, Michx. American Gromwell. C.
Gmelini (Michx.), Hitch. Gmelin's Gromwell. E.
canescens (Michx.), Lehm. Hoary Gromwell. A.
ONOSMODIUM Carolinanum (Lam.), D. C. False Gromwell. C.
Virginianum (L.), D. C. Virginia False Gromwell. C.
SYMPHYTUM officinale, L. Comfrey. C. and W.
BORRAGO officinalis, L. Borage. C.
LYCOPSIS arvensis, L. Small Bugloss. E. and C.
ECHIUM vulgare, L. Viper's Bugloss. C.

Order 94.

ACANTHACEAE. ACANTHUS FAMILY.

RUELLIA biflora, L. Pine-barren Ruellia. E.
strepens, L. Smooth Ruellia. C.
strepens micrantha (Englm.) Britton. Ruellia. C.
strepens cleistantha, Gray. Ruellia. C.
ciliosa Pursh. Hairy Ruellia. A.
ciliosa parviflora (Nees) Britton. Hairy Ruellia. A.
ciliosa ambigua, Gray. Hairy Ruellia. A.
DIANTHERA Americana, L. Water Willow. E.
ovata, Walt. Loose-flowered Water Willow. E. and C.
JUSTICIA brachiata Pursh. Justicia. E. and C.
CALOPHANES oblongifolia, Don. Calophanes. E.

Order 95.

PHRYMACEAE. LOPSEED FAMILY.

PHRYMA Leptostachya, L. Lopseed. C. and W.

Order 96.

VERBENACEAE. VERVAIN FAMILY.

VERBENA officinalis, L. European Vervain. A.
urticifolia, L. Nettle-leaved Vervain. A.
riparia, Raf. River-bank Vervain. W.
hastata, L. Blue Vervain. A.
pinnatifida, Lam. Pinnate Blue Vervain. A.
angustifolia, Michx. Narrow-leaved Vervain. C.
bracteosa, Michx. Large-bracted Vervain. C.
Aubletia, Jacq. Large-flowered Vervain. E.
LIPPIA lanceolata, Michx. Fog-fruit. E.
nodiflora, Michx. Fog-fruit. E.
CALLICARPA Americana, L. French Mulberry. C. and W.

Order 97.

LABIATAE. MINT FAMILY.

TEUCRIUM Canadense, L. Wood Sage. C. and W.
OCIMUM Basilicum, L. Sweet Basil. C.
ISANTHUR coeruleus, Michx. False Pennyroyal. C. and W.

TRICHOSTEMA dichotomum, L. Bastard Pennyroyal. C. and W.
lineare, Nutt. Narrow Bastard Pennyroyal. E.
SCUTELLARIA lateriflora, L Mad-dog Skullcap. C. and W.
serrata, Andr. Showy Skullcap. C. and W.
canescens, Nutt. Downy Skullcap. C. and W.
versicolor, Nutt Heart-leaved Skullcap. A.
versicolor minor, Chapm. Heart-leaved Skullcap. A.
pilosa, Michx. Hairy Skullcap. W.
integrifolia, L. Hyssop Skullcap. A.
parvula, Michx. Small Skullcap. E.
campestris, Britton. Prairie Skullcap. W.
saxatilis, Riddell. Rock Skullcap. W.
galericulata, L. Marsh Skullcap. W.
nervosa, Pursh. Veined Skullcap. W.
MARRUBIUM vulgare, L. Hoarhound. A.
LOPHANTHUS nepetoides, Benth. Catnip Hyssop. W.
scrophulariaefolius, Benth. Figwort Hyssop. W.
CEDRONELLA cordata, Benth. Cedronella. W.
NEPETA Cataria, L. Catnep. A.
Glechoma, Benth. Ground Ivey. A.
PRUNELLA vulgaris, L. Heal-all. A.
PHYSOSTEGIA Virginiana (L.) Benth. False Dragon-head. W.
Virginiana speciosa, small Dragon-head. C. and W.
denticulata (L.) Britton. Lion's Heart. W.
SYNANDRA hispidula (Michx.) Britton. Synandra. W.
GALEOPSIS Tetrahit, L. Hemp Nettle. A.
LEONURUS Cardiaca, L. Motherwort. A.
LAMIUM amplexicaule, L Dead Nettle. A.
maculatum, L. Spotted Dead Nettle. C.
album, L. White Dead Nettle. C.
STAHYS hyssopifolia, Michx. Hyssop Hedge Nettle. W.
ambigua (Gray), Britton. Dense-flowered Hedge Nettle. W.
tenuifolia, Willd. Smooth Hedge Nettle. W.
aspera, Michx. Rough Hedge Nettle. W.
cordata, Riddell. Cordate Hedge Nettle. W.
arvensis, L. Corn Woundwort. E.
SALVIA lyrata, L. Lyre-leaved Sage. A.
urticifolia, L. Nettle-leaved Sage. A.
Sclarea, L. Clary Sage. C.
coccinea, L. Scarlet Sage. C.
obovata, Ell. Obovate Sage. A.
officinalis, L. Garden Sage. C.
MONARDA didyma, L. Red Mountain Mint. W.
Clinopodia, L. Basal Balm. W.
fistulosa, L. Wild Bergamot W.
media, Willd. Purple Bergamot. W.
punctata, L. Horse-mint. C. and W.
BLEPHILIA ciliata (L.), Raf. Downy Blephilia. C. and W.
hirsuta (Pursh.), Torr. Hairy Blephilia. W.

HEDEOMA pulegioides (L.), Pers. Pennyroyal. A.
MELISSA officinalis, L. Lemon Balm. C.
SATUREIA hortensis, L. Savory. C.
CALAMINTHA Clinopodium, Benth. Basil-weed. C.
Nepeta, L. & H. Field Balm. C.
Caroliniana, Sweet. Carolina Balm. C.
HYSSOPUS officinalis, L. Hyssop. C.
ORIGANUM marjoranum, L. Marjoram. C.
PYCNANTHEMUM linifolium, Pursh. Narrow leaved Mountain Mint. C. and W.
lanceolatum, Pursh. Virginia Mountain Mint. C. and W.
clinopodioides, T. & G. Basil Mountain Mint. W.
hyssopifolium, Benth. Hyssop Mountain Mint. C. and W.
aristatum, Michx. Awned Mountain Mint. C. and W.
aristatum hyssopifolium, Gray. C and W.
incanum, Michx. Hoary Mountain Mint. C. and W.
Tullia, Benth. Southern Mountain Mint. C. and W.
Tullia dubium, Gray. Mountain Mint. W.
albescens, T. & G. White-leaved Mountain Mint. C.
muticum, Michx. Short-toothed Mountain Mint. E. and C.
montanum, Michx. Thin-leaved Mountain Mint. W.
leptodon, Benth. Mountain Mint. W.
Beadlei, Small. Beadle's Mountain Mint. W.
Torreyi, Benth. Torrey's Mountain Mint. W.
CUNILLA Mariana, L. Dittany. W.
LYCOPUS Virginicus, L. Bugle-weed. A.
sessilifolius, Gray. Sessile Bugle-weed. E.
rubellus, Moench. Stalked Bugle-weed. E. and C.
Americanus, Muhl: American Bugle-weed. A.
Europaeus, L. European Bugle-weed. E.
MENTHA spicata, L. Spearmint. C. and W.
piperita, L. Peppermint. A.
rotundifolia (L.), Huds. Round-leaved Mint. A.
aquatica, L. Water Mint. E. and C.
arvensis, L. Corn Mint. E. and C.
Canadensis, L. American Wild Mint. C.
COLLINSONIA Canadensis, L. Horse-balm. A.
punctata Gray. Horse balm. E.
scabriuscula, Ait. Horse-balm. C.
anisata, Pursh. Horse-balm. E. and C.
HYPTIS radiata, Wllld. Hyptis. E. and C.
MACBRIDEA pulchra, Ell. Macbridea. E.

Order 98.

PLANTAGINACEAE. PLANTAIN FAMILY.

Plantago major, L. Common Plantain. A.
Rugellii, Dec. Rugel's Plantain. A.
lanceolota, L. Snake Plantain. A.
sparsiflora, Michx Southern Plantain. E. and C.
cordata, Lam. Water Plantain. E. and C.
aristata, Michx. Large-bracted Plantain. E. and C.
Virginica, L. Dwarf Plantain. A.
pusilla, Nutt. Slender Plantain. E.
heterophylla, Nutt. Many-seeded Plantain. E. and C.

Order 99.

ARISTOLOCHIACEAE. BITTERWORT FAMILY.

Asarum Canadense, L. Wild Ginger. W.
reflexum, Bricknell. Wild Ginger. W.
Virginicum, L. Heart-leaf. A.
Virginicum grandiflorum, L. Heart-leaf. W.
macranthum (Shuttle), Small. Large heart-leaf. W.
arifolium, Michx. Halberd-leaf Heart-leaf.
Aristolochia Serpentaria, L. Virginia Snakeroot. A.
Sipho, L'Her. Dutchman's Pipe. W.
tomentosa, Sims. Woolly Pipe-vine. W.

Order 100.

PHYTOLACCACEAE. POKEWEED FAMILY.

Phytolacca decandra, L. Pokeweed. A.

Order 101.

AMARANTACEAE. AMARANTH FAMILY.

Amaranthus retroflexus, L. Rough Pigweed. A.
hybridus, L. Slender Pigweed. A.
paniculatus, L. Panicled Pigweed. A.
spinosus, L. Spring Pigweed. A.
albus, L. Tumble-weed. A.
lividus, L. Purplish Amaranth. A.
deflexus, L. Low Amaranth. A.
pumilus, Raf. Coast Amaranth. E.
Acnida cannabina, L. Salt Water-hemp. E.
resocarpa, Michx. Salt Water-hemp. E.

Order 102.

CHENOPODIACEAE. GOOSEFOOT FAMILY.

Chenopodium album, L. Lamb's Quarters. A.
album viride (L), Moq Green Quarters. A.
glaucum, L. Oak-leaved Goosefoot. A.
Boscianum, Moq. Bosc's Goosefoot. A.

CHENOPODIUM murale, L. Nettle-leaved Goosefoot. A.
ambrosioides, L. Mexican Tea. E. and C.
anthelminticum, L. Wormseed. A.
multifidum, L. Cut-leaved Goosefoot. E
ATRIPLEX hastata, L. Halberd leaved Orache. E.
arenaria, Nutt. Sea-beach Orache. E.
SALICORNIA herbacea, L. Slender Samphire. E.
Bigelovii, Tow. Bigelow's Samphire. E.
ambigua, Michx. Woody Samphire. E.
SUAEDA linearis, Moq. Sea Blite. E.
SALSOLA kali, L. Saltwort. E.

Order 103.

POLYGONACEAE. BUCKWHEAT FAMILY.

RUMEX Acetosella, L. Sheep Sorrel A.
hastatulus, Muhl. Engelmann's Sorrell. E.
salicifolius, Wein. Willow leaved Dock. E.
verticillatus, L. Swamp Dock. E.
crispus, L. Yellow Dock. A.
conglomeratus, Murr. Small Green Dock C.
sanguineus, L. Red-veined Dock. E.
pulcher,L. Fiddle Dock. E
obtusifolius, L. Bitter Dock. A.
persicarioides, L. Golden Dock. E.
FAGOPYRUM esculentum, Moluch. Buckwheat. W.
POLYGONUM emersum (Michx.), Britton. Swamp Persicaria. A.
incarnatum, Ell. Pink Persicaria. C.
Pennsylvanicum, L. Pennsylvania Persicaria. C.
Persicaria, L. Lady's Thumb. A.
setaceum, Baldw. Bristly Persicaria. W.
hydropiperoides, Michx. Wild Water Pepper. A.
Hydropiper, L. Smart-weed. A.
punctatum, Ell. Water Smart-weed. C.
punctatum robustior, Small. Water Smart-weed. E.
orientale, L. Prince's Feather. C.
Virginianum, L. Virginia Knot-weed. W.
aviculare, L. Door-weed. A.
maritimum, L. Seaside Knot-weed. E.
tenue, Michx. Slender Knot-weed. W.
Convoloulus, L. Black Bind-weed. A.
cilinode, Michx. Fringed Bind-weed. W.
scandens, L Climbing False Buckwheat. A.
cristatum, E. & G. Crested False Buckwheat. A.
sagittatum, L. Arrow-leaved Tear thumb. C. and W.
arifolium, L. Halberd leaved Tear-Thumb. E. and C.
hirsutum, Walt. Hairy Knot-weed. E.
POLYGONELLA parvifolia, Michx. Coast Joint-weed. E.
articulata (L.), Meisn. Joint-weed. E.

Order 104.

LAURACEAE. LAUREL FAMILY.

PERSEA Carolinensis, Nees. Red Bay. E.
pubescens (Parsh), Sarg. Swamp Bay. E.
SASSAFRAS officinale, Nees. Sassafras. A.
LITSEA geniculata, B. & A. Pond Spice. E.
LINDERA Benzoin, Blume. Spice-wood. A.
melissaefolia, Blume. Hairy Spice-wood. A.

Order 105.

THYMELEACEAE. MEZEREUM FAMILY.

DIRCA palustris, L. Leather-wood. E. and C.

Order 106.

SANTALACEAE. SANDALWOOD FAMILY.

COMANDRA umbellata (L.), Bastard Toad flax. A.
DARBYA umbellulata, Gray. Darbya. C.
PYRULARIA oleifera, Gray. Oil Nut. C. and W.
BUCKLEYA distichophylla, Torr. Buckleya. W.

Order 107.

LORANTHACEAE MISTLETOE FAMILY.

PHORADENDRON flavescens, Nutt. Mistletoe. A.

Order 108.

SAURURACEAE. LIZARD'S TAIL FAMILY.

SAURURUS cernuus, L. Lizard's-tail. A.

Order 109.

CERATOPHYLLACEAE. HORNWORT FAMILY.

CERATOPHYLLUM demersum, L. Hornwort. E. and C.

Order 110.

CALLITRICHACEAE. WATER STARWORT FAMILY.

CALLITRICHE palustris, L. Water Fennel. E and C.
heteraphylla, Parsh. Larger Water Fennel. E. and C.

Order 111.

PODOSTEMACEAE. RIVER WEED FAMILY.

PODOSTEMON Ceratophyllum, Michx. River-weed. E. and C.

Order 112.

EUPHORBIACEAE. SPURGE FAMILY.

PHYLLANTHUS Carolinensis, Walt. Carolina Phyllanthus. C.
CROTON glandulosus, L. Glandular. Croton. C.
capitatus, Michx. Capitate Croton. W.
monanthogynus, Michx. Single-fruited Croton. C.

CROTONOPSIS linearis, Michx. Crotonopsis. C.
ACALYPHA ostryaefolia, Ridd. Hornbean Mercury. C.
Virginica, L. Virginia Mercury. A.
gracilens, Gray. Slender Mercury. C.
TRAGIA urens, L. Eastern Tragia. W.
macrocarpa, Wild. Twining Tragia. C.
RICINUS communis, L. Castor-oil Plant. A.
JATROPA stimulosa, Michx. Spurge Nettle. A.
STILLINGIA sylvatica, L. Queen's Delight. E. and C.
EUPHORBIA polygonifolia, L. Seaside Spurge. E.
maculata, L. Spotted Spurge. A.
hypercifolia, Gray. Large Spotted Spurge. A.
corollata, L. Flowering Spurge. A.
corollata angustifolia, Ell. Flowering Spurge. A.
marginata, Pursh. White-margined Spurge. W.
dentata, Michx. Toothed Spurge. C.
Ipecacuanhae, L. Ipecac Spurge. W.
heterophylla, L. Various leaved Spurge. C.
Lathyris, L. Caper Spurge. W.
Darlingtonii, Gray. Darlington's Spurge. W.
obtusata, Pursh. Blunt-leaved Spurge. E.
commutata, Engelm. Tinted Spurge. C.
Cyparissias, L. Cypress Spurge. E.

Order 113.

URTICACEAE. NETTLE FAMILY.

URTICA dioica, L. Stinging Nettle. C. and W.
gracilis, Ait. Slender Nettle. A.
urens, L. Small Nettle. A.
LAPORTEA Canadensis, Gand. Wood Nettle. A.
PILEA pumila, Raf. Clearweed. A.
BOEHMERIA cylindrica (L.), Wild. False Nettle. A.
PARIETARIA Pennsylvanica, Mull. Pellitory. A.
debilis, Forst. Hairy Pellitory. E.

Order 114.

CANNABINACEAE. HEMP FAMILY.

HUMULUS Lupulus, L. Hop. W.

Order 115.

MORACEAE. MULBERRY FAMILY.

MORUS rubra, L. Red Mulberry. A.
alba, L. White Mulberry. A.
BROUSSONETIA papyrifera, Vent. Paper Mulberry. A.

Order 116.

ULMACEAE. ELM FAMILY.

ULMUS fulva, Michx. Slippery Elm. A.
Americana, L. American Elm. A.
alata, Michx. Whahoo Elm. A.
PLANERA aquatica (Walt.), Gmel. Water Elm. A.
CELTIS occidentalis, L. Hackberry. A.
occidentalis pumila, Porsh. Rough-leaved Hackberry. A.
Missippiensis, Bosc. Southern Hackberry. A.

Order 117.

PLATANACEAE. PLANE-TREE FAMILY.

PLANTANUS occidentalis, L. Sycamore. A.

Order 118.

JUGLANDACEAE. WALNUT FAMILY.

JUGLANS nigra, L. Black Walnut. A.
cinerea, L. White Walnut. C. and W.
CARYA amara, Nutt. Swamp Hickory. C. and W.
aquatica, Nutt. Water Hickory. E. and C.
alba, Nutt. Shell bark Hiekory. A.
tomentosa, Nutt. White-heart Hickory C. and W.
microcarpa, Nutt Cmall fruited Hickory. W.
porcina, Nutt. Pig-nut Hickory. C.
sulcata, Nutt. Shag-bark Hickory. C
Carolinae—septentrionalis, Ashe. Southern Shag-bark Hickory. C.
villosa (Sarg.), Ashe. Scurfy Hickory. C.
villosa pallida, Ashe. Scurfy Hickory. C.
glabra hirsuta, Ashe. Hickory. W.

Order 119.

CUPULIFERAE. OAK FAMILY.

FAGUS ferruginea. Ait. American Beech. A.
CASTANEA vesca, L. American Chestnut. C. and W.
pumila, Mill. Chinquapin. A.
pumila nana, Muhl. Larger Chinquapin. C. and W.
CORYLUS Americana, Walt. Hazel-nut. C. and W.
rostrata, Ait. Baked Hazel-nut. C. and W.
CARPINUS Americana, Michx. Hornbeam. A.
OSTRYA Virginica, Willd. Iron-wood. A.
QUERCUS Phellos, L. Willow Oak. A.
laurifolia, Michx. Laurel Oak. E. and C.
inbricaria, Michx. Shingle Oak. W.
einerea, Michx. High-ground Willow Oak. E.
aquatica, Catesb. Water Oak. A.
nigra, L. Black-Jack Oak. A.

QUERCUS Catesbaei, Michx. Tarkey Oak. E.
coccinea, Waug. Scarlet Oak. A.
velutina, Lam. Black Oak. A.
ruba, L. Red Oak. A.
falcata, Michx. Spanish Oak. A.
falcata pagodaefolia, Ell. Spanish Oak. A.
ilicifolia, Waug. Bear Oak. C. and W.
Rudkini, Britton. Rudkin's Oak. C.
myrtifolia, Willd. Myrtle Oak. E.
stellata, Waug. Post Oak. A.
stellata parviflora, Chap. Post Oak. E.
stellata margaretta, Ashe. Post Oak. E.
alba, L. White Oak. A.
lyrata, Walt. Over-cup Oak. E.
prinos, L. Swamp Chestnut Oak. C.
Michauxii, Nutt. Michaux's Oak. E.
bicolor, Willd. Swamp White Oak. W.
Muhlenbergii, Engelm. Chestnut Oak. C.
prinoides, Willd. Chinquapin Oak. A.
Bladenborensis, Ashe. Bladenboro Oak. E. and C.

Order 120.

MYRICACEAE. WAX-MYRTLE FAMILY.

MYRICA cerifera, L. Wax-Myrtle. E.
cerifera pumila, Michx. Wax-Myrtle. E.
Carolinensis, Mill. Bay-berry. E.
COMPTONIA asplenifolia, Gaert. Swelt Fern. C. and W.

Order 121.

BETULACEAE. BIRCH FAMILY.

BETULA nigra, L. River Birch. A.
lenta, L. Sweet Birch. W.
lutea, Michx. f. Yellow Birch. W.
ALNUS viridis, D. C. Mountain Alder. W.
serrulata, Willd. Red Alder. A.

Order 122.

SALICACEAE. WILLOW FAMILY.

SALIX nigra, Marsh. Black Willow. A.
nigra falcata, Parsh. Narrow-leaved Willow. A.
Babylonica, L. Weeping Willow. C.
purpurea, L. Purble Willow. E.
humilis, Marsh. Prairie Willow. A.
tristis, Ait. Sage Willow. A.
discolor, Muhl. Hairy Willow. E.
POPULUS albus, L. White Poplar. A.
balsamifera, L. Balsam Poplar. C. and W.

POPULUS balsamifera candidans (Ait.), Gray. Balm of Gilead. C. and W.
heterophylla, L. Downy Poplar. E. and C.
grandidentata, Michx. Large-toothed Aspen. W.
angulatus, Ait. Cottonwood. E. and C.
monilifera, Ait. E. and C.

Order 123.

PINACEAE. PINE FAMILY.

PINUS pungens, Michx. Table-Mountain Pine. C.
inops, Ait. Jersey or Scrub Pine. A.
mitis, Michx. Short-leaved Pine. A.
rigida, Miller. Pitch Pine. E. and C.
Taeda, L. Loblolly Pine. E. and C.
australis, Michx. Long leaved Pine. E.
Strobus, L White Pine. W.
Cubensis, Griseb. Pine. E.
ABIES Fraseri, Pursh. Fraser's Balsam Fir. W.
TSUGA Canadensis (L.), Carr. Hemlock. W.
Caroliniana, Engelm. Carolina Hemlock. W.
PICEA nigra, Link. Black Spruce. W.
alba, Link. White Spruce. W.
JUNIPERUS Virginiana, L. Red Cedar. A.
communis, L. Common Juniper. E
TAXODUM distichum, Rich. Bald Cypress. E.
THUJA occidentalis, L, Arbor Vitae. W.
CHAMAECYPARIS thyoides (L), B. S. P. White Cedar. E.
TAXUS minor (Michx.), Britton. American Yew. W.

Class II—Endogenous Plants.

Order 124.

PALMAE. PALM FAMILY.

SABAL Palmetto, R. & S. Cabbage Palmetto. E.
Adansonii, Guerns. Dwarf Palmetto. E.

Order 125.

ARACEAE. ARUM FAMILY.

ARISAEMA triphyllum (L.), Torr. Indian Turnip. A.
Dracontium (L.), Schoot. Green Dragon. A.
polymorphum, Small. Dragon. W.
PELTANDRA undulata, Raf. Green Arrow-arum. A.
alba, Raf. White Arrow-arum. E.

Order 126.

LEMNACEAE. DUCKWEED FAMILY.

LEMNA polyrhiza, L. Greater Duckweed. E
trisulca, L. Star Duckweed. W.
Valdiviana, Fhil. Valdivia Duckweed. E.
minor, L. Lesser Duckweed. E.
WOLFFIA Columbiana, Karst. Walffia. E.

Order 127.

TYPHACEAE. CAT TAIL FAMILY.

TYPHA latifolia, L. Broad-leaved Cat tail. A.
angustifolia, L. Narrow-leaved Cat-tail. E.
SPARGANIUM eurycarpum, Engelm. Bur-reed. C.
androcladum, Engelm. Branching Bur-reed. E. and C.

Order 128.

NAIADACEAE. PONDWEED FAMILY.

POTAMOGETON natans, L. Floating Pondweed. E. and C.
pulcher, Tuck. Spotted Pondweed. A.
Nutallii, C. & S. Nuttall's Pondweeds. E.
lonchites, Tuck. Long-leaved Pondweed. E.
lucens, L Shining Pondweed. E.
pusillus, L Small Pondweed. E. and C.
hybridus, Michx. Rafinesque Pondweed. E.
pectinuatus, L. Fennil-leaved Pondweed. E. and C.
Pennsylvanicus, Cham. Pennsylvania Pondweed. E. and C.
RUPPIA maritima, L Ruppia. E.
ZAUNICHELLIA palustris, L. Zaunichellia. E.
NAIAS marina L. Large Naias. E
flexilis, Rost. Slender Naias. E.
ZOSTERA marina, L. Eel-grass. E.

Order 129.

ALISMACEAE. WATER-PLANTAIN FAMILY.

TRIGLOCHIN triandra, Michx. Three-ribbed Arrow-grass. E.
ALISMA plantago, L. Water Plantain. A.
tenellum, Mart. Dwarf Water Plantain. C.
ECHINODORUS radicans, Engelm. Creeping Bur-head. A.
rostratus, Engelm. Upright Bur-head. A.
SAGITTARIA calcina, Engelm. Arrow head. C.
latifolia, Willd. Broad-leaved Arrow-head. A.
latifolia pubescens, Muhl. Hairy Arrow-head. A.
lancifolia, L. Lance-leaved Arrow head. E.
teres, S. Wats. Slender Arrow-head. E.
graminae, Michx. Grass Leaved Arrow-head. E.
subulata, L. Subulate Arrow head. E.

Order 130.

VALLISNERIACEAE. TAPE-GRASS FAMILY.

ELODEA Canadensis, Michx. Water Thyme. W.
VALLISNERIA spiralis, L Tape Grass. E.
LIMNOBIUM Spongia, Richard. Frog's-bit E.

Order 131.

BURMANNIACEAE. BURMANNIA FAMILY

BURMANNIA biflora, L. Northern Burmannia. E.
capitata, Chapm. Southern Burmannia. E.

Order 132.

ORCHIDACEAE. ORCHID FAMILY.

CYPRIPEDIUM acaule, Ait. Stemless Ladies Slipper. C. and W.
pubescens, Willd. Yellow Ladies Slipper. C. and W.
parviflorum, Salisb. Small Yellow Ladies Slipper. C. and W.
spectable, Salisb. Showy Ladies Slipper. W.
ORCHIS spectabilis, L. Showy Orchis. C. and W.
HABENARIA orbiculata, Torr. Large Round-leaved Orchis. W.
nivola, Spreng. Small White Orchis. E.
integra, Spreng. Small Yellow Orchis. E.
bractiata, R. Br. Long bracted Orchis. W.
clavellata, Spreng. Green Wood Orchis. W.
flava, Gray. Pale Green Orchis. E.
cristata, R. Br. Crested Yellow Orchis. C. and W.
ciliata, R. Br. Yellow Fringed Orchis. E and C.
fimbriata, Gray. Purple Fringed Orchis. E. and C.
psycodes, Gray. Small Purple Fringed Orchis. W.
blephariglottis, Torr. White Fringed Orchis. W.
blephariglottis holopetala, Gray. White Fringed Orchis. W.
peramoena, Gray. Fringeless Purple Orchis. W.
POGONIA ophioglossoides, Ker. Rose Pogonia. A.
trianthoghora, B. S P. Nodding Pogonia. W.
divaricata, R Br. Spreading Pogonia. W.
verticillata, Nutt. Whorled Pogonia. A.
ARETHUSA bulbosa, L. Arethusa. W.
SPIRANTHES cernua. Rich. Nodding Ladies' Tresses. A.
odorata, Lindl. Fragrant Ladies Tresses. C. and W.
praecox, Kuntze. Grass-like Ladies' Tresses. E.
gracilis, Beck. Slender Ladies' Tresses. W.
LISTERA convallarioides, Torr. Twayblade. W.
australis, Lindl. Southern Twayblade E.
GOODYERA repens, R. Br. Netleaf Plantain. W.
pubescens, R. Br. Netleaf Plantain. A.
MICROSTYLIS ophioglossioides, Nuet. Adder's-mouth. E.

LIPARIS liliifolia, Rich. Twayblade. W.
CORALLORHIZA odontorhiza, Nutt. Crawley-root. C. and W.
Wisteriana, Conrad. Coral-root. C.
multiflora, Nutt. Large Coral-root. C. and W.
TIPULARIA discolor, B. S. P. Crane-fly Orchis. C.
CALAPOGON pulchellus, R. Br. Grass-pink. E. and C.
pallidus, Chapm. Grass-pink. E.
parviflorus, Lindl. Grass Pink. E.
BLETIA aphylla, Nutt. Crested Crawley. A.
APLECTRUM hyemale, Nutt. Adam and Eve. A.
PONTHIEVA glandulosa, R. Br. Ponthieva. E.

Order 133.

AMARYLLIDACEAE. AMARYLLIS FAMILY.

AMARYLLIS Atamasco, L. Atamasco Lily. E. and C.
HYMENOCALLIS lacera, Salisb. Spider Lily. E.
AGAVE Virginiana, L. False Aloe. E and C.
HYPOXIS erecta, L. Star-grass. A.
juncea, Smith. Star-grass. E.

Order 134.

HAEMODORACEAE. BLOODWORT FAMILY.

LOPHIOLA aurea, Ker. Laphiola. E.
ALETRIS farinosa, L. White Colic-root. A.
aurea, Walt. Yellow Colic-root. A.
LACHNANTHES tinctoria, Ell. Red-root. E.

Order 135.

BROMELIACEAE. PINE APPLE FAMILY.

TILLANDSIA usneoides, L. Florida Moss. E.

Order 136.

IRIDACEAE. IRIS FAMILY.

IRIS versicolor, L. Blue Flag. A.
Caroliniana, Watson. Carolina Blue Flag. E.
tripetala, Walt. Blue Flag. E.
Virginica, L. Virginia Blue Flag. E. and C.
verna, L. Dwarf Blue Flag. A.
cristata, Ait. Dwarf Iris. W.
Germanica, L. Fleur-de-lis. C.
IXIA Chinensis, L. Blackberry Lily. C. and W.
SISYRINCHIUM anceps, S. Wats. Blue-eyed Grass. E. and C.
Atlanticum, Bicknell. Eastern Blue-eyed Grass. E.
angustifolium, Mill. Pointed Blue-eyed Grass. A.
Carolinianum, Bicknell. Carolina Blue-eyed Grass. W.
rufipes, Bicknell. Blue-eyed Grass. E. and C.
scabrellum, Bicknell. Blue-eyed Grass. W.

Order 137.

DIOSCOREACEAE. YAM FAMILY.

DIOSCOREA villosa, L. Wild Yam. A.

Order 138.

SMILACEAE. SMILAX FAMILY.

SMILAX herbacea, L. Carrion-flower. A.
tamnifolia, Michx. Halberd-leaved Smilax. E. and C.
ecirrhata, Wats. Upright Smilax. E. and C.
glauca, Walt. Glaucous Smilax. A.
rotundifolia, L. Horsebriar Smilax. A.
rotundifolia crenulata, Small. Horsebriar Smilax. W.
hispida, Muhl. Hispid Smilax. C.
Pseudo China, L. Long-stalked Smilax.
Bona-nox, L. Bristly Smilax W.
laurifolia, L. Laurel-leaved Smilax. E. and C.
Walteri, Pursh. Walter's Smilax. E.
lanceolata, L. Lance leaved Smilax. E. and C.
auriculata, Walt. Fragrant Smilax. E.
pedunculata, Muhl. Smilax. A.
TRILLIUM sessile, L. Wake-robin. C. and W.
grandiflorum. Salisb. Large Wake-robin. W.
erectum, L. Beth-root. A.
cernuum, L. Nodding Beth-root. A.
erythrocarpum, Michx. Painted Beth-root. A.
pusillum, Michx. Pink Beth root. E.
stylosum, Nutt. Rose Beth root. W.
MEDEOLA Virginiana, L. Indian Cucumber-root. A.

Order 139.

LILIACEAE. LILY FAMILY.

POLYGONATUM biflorum, Ell. Hairy Solomon's Seal. A.
gigantium, Diet. Smooth Solomon's Seal. A.
SMILACENIA racemosa, L. Large Solomon's Seal. A.
bifolia, Ker. Mountain Solomon's Seal. W.
stellata, L. Star-flowered Solomon's Seal. C.
CONVALLARIA majalis, L. Lily of-the-Valley. W.
CLINTONIA borealis, Raf. Yellow Clintonia. W.
umbellata, Torr. White Clintonia. C. and W.
ALLIUM tricoccum, Ait. Wild Leek. W
cernuum, Roth. Nodding Wild Onion. W.
vineale, L Wild Garlic. C.
Canadense, L. Meadow Garlic. A.
mutabile, Michx. Wild Onion. A.
striatum, Jacq. Yellow False Garlic. E.
CAMASSIA Fraseri, Torr. Wild Hyacinth. W.
ERYTHRONIUM Americanum, Smith. Dog's tooth Violet. W.
albidum, Nutt. Dog's-tooth Violet. W.

LILIUM Philadelphicum, L. Philadelphia Lily. W.
Catesbaei, Walt. Southern Red Lily. E.
Canadense, L. Wild Yellow Lily. C. and W.
superbum, L. Turk's Cap Lily. W.
Grayi, S. Wats. Asa Gray's Lily.
Carolinianum, Michx. Carolina Lily. A.
Masseyi, C. W. Hyams. Massey's Lily. W.
YUCCA filamentosa, L Christmas-bells. C and W.
gloriosa, L. Bear-grass. E.
aloifolia, L. Bear-grass. E.
ORNITHOGALUM umbellatum, L. Star of-Bethlehem. A.
MUSCARI botryoides, Mill. Grape Hyacinth. C.
ASPARAGUS officinalis, L. Asparagus. A.
HEMEROCAULIS fulva, L. Day Lily. W.
flava, L. Yellow Day Lilly. C. and W.

Order 140.

MELANTHACEAE. BUNCH FLOWER FAMILY.

TOFIELDIA glutinosa, Pers. Glutinous Tofieldia. W.
pubens, Michx. Viscid Tofieldia. E.
glabra, Nutt. White Tofieldia. E.
XEROPHYLLUM asphodeloides, Nutt. Turkey-beard. W.
setifolium, Small. Turkey-beard. W.
CHAMAELIRIUM luteum, Gray. Star-root. A.
AMIANTHEMUM muscaetoxicum, Gray. Fly-poison. A.
angustifolium, Gray. Fly poison, E.
STENANTHIUM gramineum, Morong. Stenanthium. W.
ZYGADENUS glaberrimus, Michx. Zygadenus. E.
leimanthoides, S. Wats. Pine-barren Zygadenus. W.
MELANTHIUM Virginicum, L. Bunch-flower. E. and C.
latifolium, Desr. Crisped Bunch-flower. C. and W.
parviflorum, S. Wats. Small Bunch-flower. W.
VERATRUM viridi, Ait. White Hellebore. W.
UVULARIA perfoliata, L. Perfoliate Bellwort. A.
sessiilifolia, L. Sessile Bellwort. A.
puberula, Michx. Mountain Bellwort.
STREPTOPUS amplexifolius, D. C. Twisted-stalk. C. and W.
roseus, Michx. Sessile Twisted-stalk. W.
PROSARTES lanuginosa, Don. Hairy Disporum. W.
maculata, Buckley. Mountain Disporum. W.
PLEEA tenuifolia, Michx. Pleea. E.

Order 141.

JUNCACEAE. RUSH FAMILY.

LUZULA campestris, D. C. Common Wood Rush. A.
pilosa, Willd. Hairy Wood Rush. W.
JUNCUS effusus, L. Common Rush. A.
Roemerianus, Scheele. Roemer's Rush. E.

JUNCUS bufonius, L. Toad Rush. A.
Gerardi, Loisel. Black Rush.
tenuis, Willd. Slender Rush. A
secundus, Beauv. Secund Rush. E. and C.
dichotomus, Ell. Forked Rush. E.
setaceus, Rostk. Awl-leaved Rush. E.
marginatus, Rostk. Grass-leaved Rush. A.
repens, Michx. Creeping Rush. A.
brachycarpus, Engelm. Short-fruited Rush. C.
polycephalus, Michx. Many-headed Rush. E
scirpoides, Lam. Scripus like Rush. E. and C.
megacephalus, Curtis Carolina Rush A.
Canadensis, Gay. Canada Rush. A.
Canadensis subcaudatus, Emgel. Canada Rush. A.
Canadensis longecaudatus, Emgel. Canada Rush. A.
acuminatus, Michx. Sharp-fuited Rush. A.
acuminatus debilis, Engelm. Sharp-fruited Rush. A.
Elliottii, Chapm Elliott's Rush. E
caudatus, Chapm. Rigid Rush. E.
asper, Engelm Rush. C. and W.

Order 142.

PONTEDERIACEAE. PICKEREL-WEED FAMILY.

PONTEDERIA cordata, L. Pickerel-weed. C. and W.
cordata lancifolia. Morong. Narrow Pickerel-weed. C.
HETERANTHERA reniformis, R. & P. Mud Plantain. A.
graminea, Vahl. Water Star-grass. E.

Order 143.

COMMELYNACEAE. SPIDERWORT FAMILY.

COMMELYNA nudiflora, L. Creeping Day flower. E.
Virginica, L. Virginia Day-flower. A.
hirtella, Vahl. Bearded Day flower. E. and C.
erecta, L. Slender Day-flower. E.
TRADESCANTIA Virginica, L. Spiderwort. A.
pilosa, Lehm. Zigzag Spiderwort. A.
rosea, Vent. Roseate Spiderwort. E.

Order 144.

MAYACACEAE. MAYACA FAMILY.

MAYACA Michauxii, S. & E. Mayaca. E.

Order 145.

XYRIDACEAE. YELLOW EYED GRASS FAMILY.

XYRIS flexuosa, Muhl. Slender Yellow-eyed Grass. A.
difformis, Chapm. Southern Yellow-eyed Grass. E.
Caroliniana, Walt. Carolina Yellow-eyed Grass. E.

XYRIS fimbriata, Ell. Fringed Yellow-eyed Grass. E.
torta, Smith. Twisted Yellow-eyed Grass. E. and C.
brevifolia, Michx. Pine-barren Yellow-eyed Grass. E.
ambigua, Beyr. Rigid Yellow-eyed Grass. E.
Baldwiniana, R. & S. Baldwin's Yellow-eyed Grass. E.

Order 146.

ERIOCAULONACEAE. PIPEWORT FAMILY.

ERIOCAULON decangulare, L. Ten-angled Ripewort. A.
gnaphalodes, Michx. Flattened Ripewort. A.
PAEPALANTHUS flavidulus, Kunth. Paepalanthus. E
LACHNOCAULON Michauxii, Kemth. Hairy Pipewort. E. and C.

Order 147.

CYPERACEAE. SEDGE FAMILY.

CYPERUS flavescens, L. Yellow Cyperus. A.
diandrus, Torr. Low Cyperus. A.
rivularis, Kunth. Shining Cyperus. C. and W.
microdontus, Torr. Coast Cyperus. E.
flavicomus, Michx. Elegant Cyperus. E. and C.
inflexus, Muhl. Awned Cyperus. E. and C.
compressus, L. Flat Cyperus A.
calcaratus, Nees. Marsh Cyperus. E.
Haspan, L. Sheated Cyperus. E.
dentatus, Torr. Toothed Cyperus. C.
rotundus, L. Nut grass Cyperus. A.
esculentus, L. Yellow Nut grass Cyperus. A.
esculentus angustispicatus, Britton. Yellow Nut-grass Cyperus. A.
erythrorhizos, Muhl. Red-rooted Cyperus. C.
speciosus, Vahl. Michaux's Cyperus. E
strigosus, L. Straw-colored Cyperus. A.
strigosus capitatus, Boeckl. Straw-colored Cyperus. A.
strigosus robustior, Kunth. Straw colored Cyperus. A.
refractus, Engelm. Reflexed Cyperus. W
retrofractus (L.), Torr. Rough Cyperus. A.
Lancastriensis, Porter. Lancaster Cyperus. A.
cylindricus, Ell. Pine barren Cyperus. E.
ovularis, Torr. Globose Cyperus. C.
filiculmis, Vahl. Slender Cyperus. C.
Grayi, Torr. Gray's Cyperus. E.
echinatus, Wood. Baldwin's Cyperus. A.
polystachyus, Rotth. E. and C.
stenolepis, Torr. E. and C.
tetragonus, Ell. L.
distans, L. E. and C.
virens, Michx. Cyperus. E.

KYLLINGIA pumila, Michx. Kyllingia. E. and C.
DULICHIUM spathaceum, Rich. Dulichium. E. and C.
HEMICARPA subsquarrosa, Nees. Hemicarpa. E. and C.
LIPOCARPA maculata, Torr. Lipocarpa. E.
FUIRENA squarrosa, Michx. Squarrose Fuirena. E.
hispida, Ell. Hispid Fuirena. E.
ELEOCHARIS equisetoides, Torr. Knotted Spike rush.
quadrangulata, R. & S. Quadrangular Spike-rush.
ochreata, Steud. Pale Spike rush. E.
olivacea, Torr. Bright-green Spike-rush. E.
capitata, R. Br. Capitate Spike-rush. E. and C.
palustris, R Br. Creeping Spike rush. E. and C.
acicularis, R. & S. Needle Spike rush. E. and C.
tortilis, Schultes. Twisted Spike-rush. E.
tuberculosa, R. and S. Tubercled Spike-rush. E.
microcarpa, Torr. Small-fruited Spike-rush. E.
melancarpa, Torr. Black-fruited Spike rush. E.
albida, Torr. White Spike rush. E.
tricostata, Torr. Three-ribbed Spike-rush. E. and C.
tenuis, Schultes. Slender Spike-rush. E.
acuminata, Nees. Flat-stemmed Spike-rush. E.
rostella, Torr. Beaked Spike rush. E. and C.
prolifera, Torr. Spike-rush. C.
pygmaea, Torr. Spike-rush. E.
SCIRPUS caespitosus, L. Tufted Club rush. W.
Clintoni, Gray. Clinton's Club-rush
debilis, Pursh. Weak-stemmed Club-rush. E. and C.
pungens, Vahl. Three-square Club-rush. C.
Olneyi, Gray. Olney's Bulrush. C.
leptolepis, Chapm. Canby's Bulrush. E.
lacustris, L. Great Bulrush.. A
sylvaticus, L. Wood Bulrush. A.
atrovirens, Muhl. Dark-green Bulrush. C and W.
polyphyllus, Vahl. Leafy Bulrush. C
ERIOPHORUM Virginicum, L. Virginia Cotton-grass. E.
FIMBRISTYLIS spadicea, Vahl. Stiff Fimbristylis. E.
spadicea puberula, Chapm. Fimbristylis. E.
castanea, Vahl. Marsh Fimbristylis E.
laxa, Vahl. Weak Fimbristylis. A.
Vahlii, Link. Vahl's Fimbristylis. W
autumnalis, R. & S. Slender Fimbristylis. A.
ISOLEPIS capillaris, R. & S. Isolepis. E
ciliatifolia, Torr. Isolepis. E.
stenophylla, Torr. Isolepis. E.
RHYNCHOSPORA corniculata. Gray. Horned Rush. E.
corniculata macrostachya (Torr), Britton. E.
pallida, Curtis. Pale Beaked-rush. E.
oligantha, Gray. Few-flowered Beaked-rush. E. and C.

RHYNCHOSPORA alba (L.), Vahl. White Beaked-rush. A.
glomerata (L.), Vahl. Clustered Beak-rush. E. and C.
glomerata paniculata (Gray), Chapm. Clustered Beak-rush. E. and C.
glomerata discutiens, Clarke. Clustered Beaked-rush. E. and C.
cephalantha, Gray. Capitati Beaked-rush. C.
gracilenta, Gray. Slender Beaked-rush. E.
cymosa, Ell. Gress like Beaked-rush. E. and C.
Torreyana, Gray. Torrey's Beaked-rush. E.
inexpansa (Michx.), Vahl. Nodding Beaked-rush. A.
plumosa, Ell. Beaked rush. E.
microcarpa, Baldw. Beaked-rush. C.
miliacea, Gray. Beaked-rush. E. and C.
Grayii, Kunth. Gray's Beaked-rush. E.
megalocarpa, Gray. Beaked-rush. E.
ciliata, Vahl. Beaked-rush. E.
fascicularis, Nutt. Beaked-rush. E.
fuscoides, Bolkl. Beaked-rush. E.
filifolia, Gray. Beaked rush. E.
PSILOCARYA nitens (Vahl.), Wood. Short-beaked Bald-rush. E.
DICHROMENA Leucocephala, Michx. Narrow-leaved Dichromena. E.
latifolia, Baldw. Broad-leaved Dichromena. E.
CLADIUM mariscoides, Torr. Twig-rush. A.
effusum, Torr. Saw-grass. A.
SCLERIA oligantha, Michx. Few-flowered Nut-rush. E.
triglomerata, Michx. Tall Nut-rush. E. and C.
veticularis, Michx. Reticulated Nut-rush. E.
veticularis pubescens, Britton. Pubescent Nut-rush. E.
veticularis obscura, Britton. Obscure Nut-rush.
Torreyana, Walp. Torrey's Nut-rush. E.
pauciflora, Muhl. Papillose Nut-rush. E.
verticillata, Muhl. Low Nut-rush. E. and C.
Elliottii, Chapm. Elliott's Nut-rush. E.
CAREX Collinsii, Nutt. Collins' Sedge. E
intumescens, Rudge. Bladder Sedge. E and C.
Asa-Grayi, Bailey. Gray's Sedge. E. and C.
grandis, Bailey Large Sedge. C.
bullata, Schk. Button Sedge. A.
lurida, Vahl. Sallow Sedge. E. and C.
lurida flaccida, Bailey. Sallow Sedge. C.
Frankii, Knutt. Frank's Sedge. E.
squarrosa, L. Squarrose Sedge. E.
typhinoides, Schwein. Cat-tail Sedge. E. and C.
scabrata, Schwein Rough Sedge. W.
vestita, Willd. Velvet Sedge. C.
Walteriana, Bailey. Walter's Sedge. E.
torta, Boott. Twisted Sedge. C. and W.

CAREX prasina, Wahl. Drooping Sedge. W.
littoralis, Schwein. Barratt's Sedge. E.
gynandra, Schwein. Nodding Sedge. W.
virescehs, Muhl. Downy Green Sedge. C. and W.
Costellata, Britton. Ribbed Sedge. W.
triceps, Michx. Hirsute Sedge. C. and W.
Caroliniana, Schwein. Carolina Sedge. C.
gracillima, Schwein. Graceful Sedge. C.
aestivalis, Curtis. Summer Sedge. W.
tenuis Rudge. Slender-stalked Sedge. W.
oblita, Steud. Dark-green Sedge. C.
grisea, Wahl. Gray Sedge. A.
amphibola, Steud. Narrow-leaved Sedge. C.
flaccosperma, Dewey. Thin-fruited Sedge. W.
polymorpha, Muhl. Variable Sedge. C and W.
tetanica, Schk. Wood's Sedge. E. and C.
Meadii, Dewey. Mead's Sedge. E.
laxiflora, Lam. Loose-flowered Sedge. W.
laxiflora patulifolia, Carey. Sedge. W.
blanda, Dewey. Sedge. W.
styloflexa, Buckley. Bent Sedge. C.
digitalis, Willd. Wood Sedge. C. and W.
ptychocorpa, Steud. Thicket Sedge. C.
pedicellata (Dewey), Britton. Fibrous-rooted Sedge. W.
Pennsylvainca, Lam. Pennsylvania Sedge. W.
nigro—margierata Schwein. Black-edged Sedge. C.
Fraseri, Andr. Fraser's Sedge. W.
leptalea, Wahl. Bristle-stalked Sedge. W.
stipata, Muhl Awl-fruited Sedge. C. and W.
vulpinoidea, Michx. Fox Sedge. C.
rosea, Schk. Stellati Sedge. C. and W.
rosea radiata, Dewey. Stellati Sedge. C. and W.
cephalaphora, Muhl. Oval-headed Sedge. C.
Mitchelliana, Curtis. Mitchell's Sedge. C.
bromoides, Schk. Broom like Sedge. E.
decomposeta, Muhl. Large-panicled Sedge. C.
retroflexa, Muhl. Reflexed Sedge. W.
tribuloides, Wahl. Blunt broom Sedge. W.
tribuloides Bebbii, Bailey. Blunt-broom Sedge. W.
straminea, Wild. Straw Sedge. W.
straminea foenea, Torr. Straw Sedge. W.
straminea mirabilis, Dewey. Straw Sedged. W.
alata, Torr. Broad-winged Sedge. E.
crinita, Lam. Fringed Sedge. A.
gynandra, Schwein. Nodding Sedge. E.
Willdenovii, Schk. Willdenow's Sedge. W.
fusca, All. Brown Sedge. W.
Davisii, S. & Torr. Davis' Sedge. W.

CAREX conoidea, Schk. Field Sedge. W.
oligocarpa, Schk. Few-fruited Sedge. W.
plantaginea, Lam. Plantain-leaved Sedge. W.
folliculata australis, Bailey. Folliced Sedge. E. and C.
oblita, Steud. Dark green Sedge. E.
juncea, Willd. Juncus Sedge. W.
verrucosa, Muhl. Glaucous Sedge. E.
turgescens, Torr. Chamrel leaved Sedge. E.
riparia, Curtis. River-bank Sedge. A.

Order 148.

GRAMINEAE. GRASS FAMILY.

TRIPSACUM dactyloides, L. Gama Grass. A.
ANTHOXANTHUM odoratum, L. Sweet Vernal Grass. C.
ERIANTHUS alopecuroides (L.), Ell. Spiral-awned Beard Grass. A.
saccharoides, Michx. Plume Grass. E.
compactus, Nash. Contracted Plume Grass. E. and C.
brevibarbis, Michx. Short beared Plume Grass. A.
STIPA avenacea, L. Feather Grass. E.
MANISURIS rugosa, Kuntze. Wrinkled Manisuris. E.
granularis, Swartz. Manisuris. C.
ANDROPOGON scoparius, Michx. Broom Beard-grass. A.
argyraeus, Schultes. Silvery Beard-grass. A.
furcatus, Muhl. Forked Beard-grass. C.
Virginicus, L. Virginia Beard-grass. C.
glomeratus (Walt.), B. S. P. Bushy Beard-grass. E.
Elliattii, Chapm. Elliott's Beard-grass. C.
CHRYSOPOGON avenaceus (Michx.), Benth. Indian Grass. A.
SORGHUM Halopense (L.), Pers. Johnson-grass. A.
NAZIA raceniosa (L.), Kuntze. Prickle grass. E.
PASPALUM mucronatum, Muhl. Water Paspalum. E. and C.
racemulosum, Nutt. C.
membranaceum, Walt. Walter's Paspalum. E.
purpurascens, Ell. C.
distichum, L. Joint grass. A.
dilatatum, Poir. Tall Paspalum. A.
setaceum, Michx. Slender Paspalum. A.
ciliatifolium, Michx. Ciliate leaved Paspalnm. C.
ciliatifolium dasyphyllum, Ell. Paspalum. C.
longipedunculatum, LeConte. Long-stalked Paspalum. E. and C.
laeve, Mich. Field Paspalum. A.
Floridanum, Michx. Florida Paspalum. A.
praecox, Walt. E.
compressum (Sw.), Nees. Flat Paspalum. A.
difforme, LeConte. E.
paspaloides (Michx.), Scrib. Crab-grass Paspalum. A.
furcatum, Flugge. Paspalum. E.

MILIUM amphicarpon, Pursh. Amphicarpon. E.
PANICUM consanguineum, Kath. C.
Addisonii, Nash. E.
Ashei, Pearson. Ashe's Amphicarpon. E
Scribnerianum, Nash. Scribner's Amphicarpon. E. and C.
scoparium, Lam. C.
scabriusculum, Ell. E.
Joori, Vasey. Joor's Amphicarpon. C.
macrocarpon, LeConte. Amphicarpon. W.
gibbum, Ell. Gibbons Amphicarpon. E. and C.
verrucosum, Muhl. Warty Amphicarpon. E.
capillare, L. Witch-grass Amphicarpon. A.
proliferum, Lam. Spreading Amphicarpon. E. and C.
miliaceum, L. Millet. C.
amarum, Ell. Sea-beach Amphicarpon. E.
Crus-galli, L. Barnyard Grass A.
Walteri, Pursh Salt-marsh Cockspur. E.
digitarioides, Carpenter. Narrow Panicum. E. and C.
hians, Ell. Gaping Panicum. A.
anceps, Michx. Beaked Panicum E. and C.
agrostidiforme, Lam. Agrostis-like Panicum. E.
elongatum, Pursh. Long Panicum. A.
sphaerocarpon, Ell. Round fruited Panicum. A.
microcarpon, Muhl. Small fruited Panicum. A.
Porterianum, Nash. Porter's Panicum. C.
commutatum, Schultes. Variable Panicum. A.
clandestinum, L. Hispid Panicum. E. and C.
laxifl rum, Lam. Lax-flowered Panicum. C.
depauperatum, Muhl. Starved Panicum. C.
angustifolium, Ell. Narrow-leaved Panicum. A.
neuranthum, Griseb. E.
nemopanthum, Ashe. E. and C.
dichatonum, L. A.
dichatonum elatum, Vasey. C.
maculatum, Ashe. C.
Roanakense, Ashe E. and C.
demissum, Trin. E and C
Mattamusketense. Ashe. E.
erisifolium, Bald. C.
Wrightianum, Scrib. E
sphagnicolum, Nash. C. and W.
lucidum, Ashe. E.
Cuthbertii, Ashe. C.
parvispiculatum, Nash. E.
leucothrix, Nash E
huachucae, Ashe. C.
viscidum, Ell. E. and C.

PANICUM ciliferum, Nash. E.
Atlanticum, Nash. E.
haemacorpon, Ashe. C.
arenicolum, Ashe. C.
annulum, Ashe. C.
meridionale, Ashe. C. and W.
filiculme, Ashe. C.
microphyllum, Ashe. C.
glabrissinum, Ashe. E.
Nashianum, Scrib. E.
scrotinum, Trin. C.
laniginosum, Ell. E.
Columbianum, Scrib. C.
SETARIA glauca, Beauv. Yellow Fox-tail Grass. A.
viridis, Beauv. Green Fox-tail Grass. A.
Italica, R. & S. Hungarian Fox-tail Grass. C.
verticillata, Beauv. Fox-tail Grass. A.
CENCHRUS tribuloides, L. Hedge-hog Grass. E.
incertus, Curtis. Hedge-hog Grass. E
ZIZANIA acquatica, L. Wild Rice. E.
miliacea, Michx. Wild Rice. E.
LEERSIA Virginica, Willd White Grass. E.
oryzoides, Sw. Rice-cut Grass. E.
lenticularis, Michx. Catch-fly Grass. E
HYDROCLOA Carolinensis, Beav. E.
PHLEUM pratense, L. Timothy. A.
CINNA arundinacea, L. Wood Reed. A.
latifolia, Griseb. Slender Wood Reed. A.
HOLCUS lanatus, L. Velvet or Meadow Grass. A.
DACTYLIS glomerata, L. Orchard Grass. A.
POA annua, L. Annual Meadow Grass. A.
compressa, L. Flat-stemmed Meadow Grass. A.
pratensis, L. Kentucky Blue Grass. A.
trivialis, L. Roughish Meadow Grass. A.
flexuosa, Muhl. Flexuous Spear Grass. C.
sylvestris, Gray. Sylvan Spear Grass. C. and W.
alsodes, Gray. Grove Spear Grass. C. and W.
brevifolia, Muhl. Short-leaved Spear Grass C. and W.
GLYCERA elongata, Trin. Long Mauna Grass. C. and W.
nervata, Trin. Nerved Mauna Grass. C. and W.
pallida, Trin. Pale Mauna Grass. E. and C.
FESTUCA Myurus, L. Rat's tail Fescue Grass. A.
elatior, L. Meadow Fescue Grass. A.
nutans, Willd. Nodding Fescue Grass. C. and W.
BROMUS ciliatus, L. Fringed Brome-grass. A.
hordeaceus, L. Soft Brome-grass. C.
secalinus, L. Cheat Brome-grass. A.
racemosus, L. Upright Brome-grass. C.

LOLIUM temulentum, L. Darnell Grass. C.
HORDEUM pratense, Huds. Meadow Barley. A.
ANTHAENANTIA villosa, Benth. Anthaenantia. E.
rufa, Benth. Purple Anthaenantia. E.
PHALARIS intermedia. Bosc. Canary Grass. E.
HIEROCHLOE borealis, R. & S. Seneca Grass. C.
ALOPECURUS geniculatus, L. Marsh Fox-tail. A.
pratensis, L. Meadow Fox-tail. A.
SPOROBOLUS asper, Kunth Rough Rush-grass. A.
vaginaeflorus, Wood. Sheathed Rush grass. A.
vaginaeflorus minor, Vasey Sheathed Rush-grass W.
Virginicus, Kunth Seashore Rush-grass. E
Indicus, Brown. Smut Rush grass A.
Junceus, Kunth. Wire-grass. E. and C.
cryptandrus, Gray. Wire-grass. E.
AGROSTIS alba, L. Herd's grass. A.
rubra, L Red Bent grass. W.
perennans, Tuck. Thin Grass W.
scabra, Willd. Rough-Hair Grass. A.
elata, Trin. Tall-Bent Grass. E.
Novae–Angliae, Tuck. New England Bent-grass. W.
canina, L. Mountain Bent-grass. W.
POLYPOGON maritimus, Willd. Beard Grass. E.
CALAMAGROSTIS Canadensis, Beauv. Blue joint Grass. W.
Nuttalliana, Steud. Nuttall's Reed Grass. A.
arenaria, Roth. Sand reed Grass. E.
ARISTIDA dichotoma, Michx. Poverty Grass A.
gracilis, Ell. Slender Poverty Grass. A.
purpurascens, Poir. Purplish Poverty Grass. A.
lanata, Poir. Woolly Poverty Grass. A.
virgata, Trin. Virgate Poverty Grass. E.
stricta, Michx. Erect Poverty Grass. E. and C.
MUHLENBERGIA sobolifera, Trin. Rock Muhlenbergia C.
Mexicana, Trin. Meadow Muhlenbergia. A.
glomerata, Trin. Marsh Muhlenbergia. C.
sylvatica, T. & G. Wood Muhlenbergia. W.
diffusa, Schreb Drop-seed Muhlenbergia. A.
capillaris, Kunth. Long-awned Muhlenbergia. E.
BRACHYELYTRUM erectum, Beauv. Brachyelytrum. W.
AIRA caryophyllea, L. Silvery Hair-grass. C.
DESCHAMPSIA flexuosa, Trin. Navy Hair-grass. W.
TRISETUM subspicatum, Beauv. Narrow False Oat. W.
palustris, Michx. Marsh False Oat. A.
DANTHONIA spicata, Beauv. Common Wild Oat-grass. A.
sevicea, Nutt. Silky Wild Oat-grass. A.
compressa, Austin. Flattened Wild Oat-grass. W.
glabra, Nash. Smooth Wild Oat-grass. E.
ARRHENATHERUM elatius, Beauv. Oat-grass. A.

SPARTINA polystacha, Ell. Salt Reed grass. E.
juncea, Willd. Salt-meadow Grass. E.
stricta, Roth. Smooth Marsh Grass. E.
stricta glabra, Muhl. Smooth Marsh Grass. E.
stricta alternifolia, Lois. Smooth Marsh Grass. E.
GYMNOPOGON racemosus, Beauv. Gymnopogon. E.
brevifolius, Trin. Gymnopogon. E.
CHLORIS petraea, Swartz. Chloris. E.
CYNODON Dactylon, Pers. Bermuda Grass. A
CTENIUM Americanum, Spreng. Toothache Grass. E
ELEUSINE Ægyptiaca, Pers. Crowfoot Grass. A.
Indica, Gaert. Crab Grass. A.
LEPTOCLOA mucronata, Kunth. Leptocloa. A.
DIPLACHNE fascicularis, Beauv. Diplachne. E
rigida, Munro. Diplachne. E
TRIODIA cuprea, Jacq. Tall Red top. A.
TRIPLASIS Americana, Beauv. Triplasis. E.
purpurea, Chapm. Triplasis. E.
MELICA mutica, Walt. Mellic Grass. E.
diffusa, Pursh. Mellic Grass. E.
EATONIA Dudleyi, Vasey. Dudley's Eatonia. W.
obtusata, Gray. Blunt Eatonia. E and C.
Pennsylvanica, Gray. Pennsylvania Eatonia. C.
ERAGROSTIS reptans, Nees. Creeping Eragrostis A.
megastachya, Link. Eragrostis. A.
ciliaris, Link. Eragrostis. A.
Purshii, Schrad. Pursh's Eragrostis. A.
pilosa, Beauv. Tufted Eragrostis. C.
tenuis, Ell. Hairy Eragrostis. E and C.
capillaris, Nees. Capillary Eragrostis. A.
pectinacea, Gray. Purple Eragrostis. C.
campestris, Trin. Meadow Eragrostis.
UNIOLA gracilis, Michx. Slender Spike grass. A.
latifolia, Michx. Broad Spike-grass. E and C.
paniculata, L. Sea Oats. E
spicata, L. Marsh Sea Oats E.
PHRAGMITES communis, Trin. Reed. E.
AGROPYRUM repens, Beauv. Conch-grass. A.
Caninum, R. & S. Conch grass. A.
ELYMUS robustus, Scrib Stout Rye Grass. E, and C.
Virginicus, L. Virginia Rye Grass. A.
striatus, Willd. Nodding Rye Grass. C.
ASPRELLA Hystix, Willd. Bottle-brush. C.
ARUNDINARIA macrosperma, Michx. Cane. A.
tecta, Muhl. Reed. A.

Class III—Acrogens.

Cryptogamons or Flowerless Plants.

Order 149.

EQUISETACEAE. HORSE-TAIL FAMILY.

Equisetum laevigatum, Braun. Smooth Scouring-rush. A.
hyemale, L. Common Scouring-rush. W.
sylvaticum, L Wood Horse-tail. E.
arvense, L. Field Horse-tail. C.

Order 150.

OPHIOGLOSSACEAE. ADDER'S TONGUE FAMILY.

Botrychium ternatum (Thimb.), Sw. Ternate Grape fern. E. and C.
dissectum. Grape-fern. E. and C.
Virginianum (L.), Sw. Virginia Grape-fern. A.

Order 151.

POLYPODIACEAE. FERN FAMILY.

Polypodium vulgare, L. Common Polypody. C. and W.
vulgare cristatum. Common Polypody. W.
valgare Cambricum. Common Polypody. W.
incanum, Sw. Tree Polypody. E. and C.
Pteris aquilina, L. Rock Brake. A.
aquilina caudata (L), Hook. Rock Brake. E.
tremuloides. C.
Pellaea atropurpuria, Link Cliff-brake. W.
Cheilanthes Alabamensis, Kuntze. Alabama Lip-fern. W.
lanosa, Walt. Hairy Lip-fern. W.
tomentosa, Link. Woolly Lip-fern. W.
Adiatum Capillus-Veneris, L. Venus-hair Fern. E.
pedatum, L. Maiden-hair Fern. A.
Woodwardia Virginica, Smith. Virginia Chain Fern. A.
angustifolia, Smith. Net veined Chain Fern. E. and C.
Camptosorus rhizophyllus, Link. Walking-fern. W.
Asplenium pinnatifidum, Nutt. Pinnatifid Spleenwort. W.
ebenoides, Scott. Scott's Spleenwort. W.
parvulum, M. & G. Small Spleenwort. W.
platyneuron, Oakes. Ebony. C. and W.
Trichomanes, L. Maiden-hair Spleenwort. W.
angustifolum, Michx. Narrow-leaved Spleenwort. W.
Ruta-muraria, L. Wall Rue Spleenwort. W.
montanum, Willd. Mountain Spleenwort. W.
Bradleyi, Eaton. Bradley's Spleenwort. W.
thelypteroides, Michx. Silvery Spleenwort. A.

ASPLENIUM Filix-foemina, Bernh. Lady-fern. A.
dentatum, L. Spleenwort. W.
CYSTOPTERIS bulbifera, Bernh. Bulbous Brittle Fern. W.
fragilis, Bernh. Brittle Fern. W.
ASPIDIUM acrostichoides, Sw. Christmas Fern. A.
acrostichoides Schweinitzii. Christmas Ferm. A.
Noveboracense, Sw. New York Fern. W.
Thelipteris, Sw. Shield Fern. A.
Goldieanum, Hook. Goldie's Fern. C. and W.
marginale, Sw. Wood Fern. C. and W.
spinulosum, Sw. Spinulose Shield Fern. W.
spinulosum intermedium, Eaton. Spinulose Shield Fern. W.
spinulosum dilatatum, Hook. Spinulose Shield Fern. W.
PHEGOPTERIS polypodioides, Fee. Long Beech Fern. W.
hexagonoptera, Fee Broad Beech Fern. A.
Drypopteris, Fee Oak Fern. E. and C.
DICKSONIA punctilobula (Michx.), Grav. Hay-scented Fern. W.
LYGODIUM palmatum, Sw. Climbing Fern. A.
ONOCLEA sensibilis, L. Sensitive Fern. A.
WOODSIA Ilvensis, R. Br. Rusty Woodsia. W.
obtusa, Torr. Blunt-lobed Woodsia. W.
OSMUNDA cinnamomea, L. Cinnamon Fern. A.
regalis, L. Royal Fern. A.
Claytoniana, L. Clayton's Fern. A.

Order 152.

LYCOPODIACEAE. CLUB-MOSS FAMILY.

LYCOPODIUM lucidulum, Michx. Shining Club moss. W.
Selago, L. Fir Club moss. W.
clavatum, L. Running Club-moss. W.
dendroideum, Michx. Ground Pine Club moss. W.
Carolinianum, L Carolina Club-moss. E.
complanatum, L. Christmas Club-moss. W.
innudatum, L. Bog Club-moss. E.
alopecuroides, L. Fox tail Club-moss. E.
alopecuroides adpressum, Chapm. Club-moss. E.

Order 153.

SELAGINELLACEAE SELAGINELLA FAMILY.

SELAGINELLA rupestris, Spring. Rock Selaginella. A.
apus, Spring. Creeping Selaginella. A.

Order 154.

SALVINIACEAE. SALVINIA FAMILY.

AZOLLA Caroliniana, Willd. Carolina Azolla. E.

INDEX.

BULLETIN NO. 165 JUNE 1, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR.

Preservatives in Canned Foods

Offered for Sale in North Carolina.

W. A. WITHERS AND H. W. PRIMROSE

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E. EMERY, M.S., Agriculturist.*
W. F. MASSEY, C.E., Horticulturist.*
COOPER CURTICE, D.V.S., M.D., (1) Veterinarian.*
G. S. FRAPS, Ph.D., Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES, Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist.
J. M. JOHNSON, M.S., Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B.E., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M., State Chemist.
C. B. WILLIAMS, M.S., Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY, Assistant Chemist.
W. G. HAYWOOD, B.LITT., Assistant Chemist.
H. E. KING, Chief Clerk.
MISS M. S. BIRDSONG, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

*Member of Station Council.
(1) On leave of absence.

PRESERVATIVES IN CANNED FOODS

OFFERED FOR SALE IN NORTH CAROLINA.

W. A. WITHERS, A. M., CHEMIST.
H. W. PRIMROSE, B. S., ASSISTANT CHEMIST.*

ACKNOWLEDGMENT.

Acknowledgment is hereby made for the valuable information contained in BULLETINS 13 (part VIII) and 51 of the Division of Chemistry of the United States Department of Agriculture. The reader is referred to these bulletins for a full discussion relating to the subject of canning, preservatives, etc.

PRESERVATION OF FOOD BY CANNING.

The various articles for human consumption will undergo change upon exposure to the air for a greater or less period of time, and as a result various gases are given off, some of which are ill smelling, and the substances left behind are unfit for food. It was formerly thought that these changes were brought about by the oxygen of the air. More recent investigations have shown that they are caused by minute living organisms, which are found in the air, water and the food itself. In order to keep the foods "fresh" and wholesome it is necessary for us to kill the living organisms which are present, and to exclude others. If we maintain a sufficient temperature for a sufficient time the organisms are destroyed.

Heat kills the organisms, and a vessel sealed air-tight will keep out the organisms which are present in the air. The method therefore which at once suggests itself is to sterilize the can and the food by heating to a sufficiently high temperature, and sealing the can while hot. As this is done at a high temperature when the can cools there will be a contraction, in consequence of which the end of the can will be depressed. This depression is an indication that no fermentation has taken place since sealing. *A "swelled" can has certainly undergone fermentation of its contents, and should not be used.* When cans are opened the entire contents should be removed immediately, and a very long period of time should never be allowed to elapse between the opening of the can and the eating of its contents.

---

*Except where a statement to the contrary is made, the analytical work was performed by Mr. Primrose, under direction of the Chemist.

DIFFICULTIES ENCOUNTERED IN CANNING.

Although the method outlined above is extremely simple, and is doubtless practiced by every housekeeper to some extent, yet there are difficulties which are also familiar. Although heating will destroy the germs yet in some instances it is necessary to continue boiling for a greater or less period of time in order that the interior may reach the boiling point and thus be completely sterilized. The effects of prolonged boiling are the softening or falling to pieces of the articles of food, and in some instances the abstraction of a part of the original color, which diminishes the attractiveness of the food.

Incomplete sterilization would, of course, leave germs present to bring about the decay.

PRESERVATIVES.

A remedy for the extended boiling is to add some substance which is capable of destroying the living organisms. Such substances are called preservatives. If such substances were used without boiling it would be necessary to add very large quantities. The method usually followed, is to add the preservative, seal, heat, make a little hole to allow the escape of the air and then seal up the little hole. By heating, it is not necessary to add such large quantities of the preservative. For vegetables the most common preservative is salicylic acid, and after it sulphurous acid, in the form of sulphites. Benzoic acid, hydronaphthol, fluorides, formaldehyde, etc., are probably used also. For canned meats boric acid and borax are probably the more important preservatives.

As to the harmfulness of these added preservatives, there may be a question. There is probably no fairer statement to both canner and consumer than that of Dr. Wiley:

"First, that the use of added preservatives is, upon the whole, objectionable; second, that their absolute inhibition is not warranted by the facts which have come to our knowledge, but in all cases their presence should be marked on the label of the can." With this information the consumer, with the advice of his physician, may judge for himself as to the danger of eating canned foods.

OTHER FOREIGN SUBSTANCES.

Boiling of vegetables tends to remove the original color and to soften them. The use of copper for greening is old, and while the addition of copper and zinc in small quantities may not be injurious to health, yet it would seem proper for the presence of these substances and their amounts to be stated on the labels of the cans, just as is recommended in the case of preservatives.

Other substances which may be present are lead and tin which may be dissolved from the can or the solder. The presence of lead is

particularly objectionable, and it would seem that legislation fixing the maximum amount of lead to be used in the tin and the solder would be desirable.

In this investigation the principal object was to determine the extent to which preservatives were used, and tests were not made for the presence of the metals, except in a few instances.

COLLECTION OF SAMPLES.

The samples were bought upon the open market by some member of the Station staff, in Durham, Greensboro, and Statesville, and may be taken as representative of the canned foods on sale in the State.

METHODS OF ANALYSIS.

The methods followed were those given in Bulletins 13 (part VIII) and 51 of the Division of Chemistry of the United States Department of Agriculture.

Very few samples were examined for metals, the principal object being to detect the preservatives if present. In nearly every sample tests were made for salicylic and sulphurous acids, benzoic and boric acids, hydronaphthol, formaldehyde and fluorides.

SUMMARY OF RESULTS.

Eleven samples of fruits were examined and all (*equivalent to one hundred per cent*) were found to contain preservatives, and no mention of this was made on the label. The list includes two samples of apples, one of pineapple, three of peaches, and three of blackberries which contained salicylic acid, and one sample each of peaches and of blackberries which contained both salicylic and sulphurous acids.

Twenty samples of vegetables were examined, and twelve (*representing sixty per cent*) were found to contain preservatives, and no mention of this was made on the label. This list included five samples of tomatoes, two of peas, one of corn, and two of pork and beans, in which salicylic acid was found, and two of corn in which both salicylic and sulphurous acids were found. One sample each of lima beans, snap beans, tomatoes, baked beans with tomato sauce, and succotash, and three of corn, contained no added preservative.

One sample each of clams, sausage, steak, potted tongue, and two samples each of oysters and salmon were examined, but no added preservative was found.

As a summary of the whole it may be stated that no added preservative was found in the canned meats, but that one hundred per cent of the canned fruits and sixty per cent of the canned vegetables contained salicylic acid, and that eighteen per cent of the fruits and ten per cent of the vegetables contained in addition sulphurous acid.

Metals were not tested for in all the samples, but they were found in several of those where tests were made for them.

In view of these facts the wisdom of the State legislation on the subject of food adulteration is apparent.

DESCRIPTION OF SAMPLES.

1047 *Lima Beans, Pilgrim.*—Packed by Bennett Sloan & Co., New York. Bought in Statesville, N. C. No preservative was found.

1048 *Heinz's Baked Beans, with Tomato Sauce.*—H. J. Heinz & Co., Pittsburg, Pa. Bought in Statesville, N. C. No preservative was found.

1049 *Apples, Jumbo Brand.*—Packed by Miller Bros., Baltimore, Md. Bought in Statesville, N. C. Salicylic acid was found.

1050 *Select Cherry Stone Lunch Oysters.*—Packed by Martin Wagner & Co., Baltimore, Md. Bought in Statesville, N. C. No preservative was found.

1051 *Cove Oysters.*—Berkeley Canning and Manufacturing Co., Mt. Pleasant, S. C. Bought in Statesville, N. C. No preservative was found.

1052 *Vienna Sausage, Extra Quality.*—Packed by Armour & Co., Chicago, Ill. Bought in Statesville, N. C. No preservative was found.

1053 *First Quality Blackberries.*—Packed by Mountain View Cannery, A. G. Corpening, Prop., Cora, N. C. Bought in Statesville, N. C. Salicylic acid was found.

1054 *Potted Tongue, Kingan's Reliable...Best Quality.*—Kingan & Co., Indianapolis, Ind. Bought in Statesville, N. C. No preservative was found.

1055 *Fresh Clams...Little Neck. Bar Harbor Brand.*—Packed by A. E. Farnsworth, Southwest Harbor, Mt. Desert, Me. Bought in Statesville, N. C. No preservative was found.

1056 *Superior Minced Steak.*—Packed by Armour & Co., Chicago, Ill. Bought in Statesville, N. C. No preservative was found.

1057 *Premier Columbia River Salmon.*—Packed by Frances H. Leggett & Co., New York. Bought in Statesville, N. C. No preservative was found.

1058 *Pilgrim Tomatoes.*—Packed by Bennett Sloan & Co., New York. Bought in Statesville, N. C. Salicylic acid was found.

1059 *Tomatoes.*—Packed by J. P. Collins, Troutman, N. C. Bought in Statesville, N. C. No preservative was found.

1060* *Sweet Corn. Iredell Brand.* Packed by J. P. Collins, Troutman, N. C. Bought in Statesville, N. C. No preservative was found.

1061* *Sunbeam Corn.*—Packed by Austin Nichols & Co., New York. Bought in Statesville, N. C. No preservative was found.

---

* **Analysis by Mr. J. A. Bizzell, under direction of the Chemist.**

1070* *Succotash.*—Packed by Wayne Co. Preserving Co., Fairpoint, New York. Bought in Statesville, N. C. No preservative was found.

1318 *Dixie Brand Salmon.*—Queen Packing Co., Aberdeen, Washington. Bought in Durham, N. C. No preservative was found.

1319 *Tomatoes. . .First Quality.*—Packed by Beal, Adams & Co., Bel-Air, Md. Bought in Durham, N. C. Salicylic acid was found.

1320 *First Quality Pie Peaches.*—Packed by Thomas J. Myer & Co., Baltimore, Md. Bought in Durham, N. C. Salicylic and sulphurous acids were found.

1321 *Royal Beauty Tomatoes.*—Packed by W. B. Davie & Co., Richmond, Va. Bought in Durham, N. C. Salicylic acid was found in small quantity.

1322 *Royal Red Brand California Lemon Cling Peaches.*—Packed by Sacramento Preserving Co. Bought in Durham, N. C. Salicylic acid was found in small quantity.

1323 *Turtle Dove Brand Peaches, First Quality.*—Packed by Jordan Trotter & Co., Cambridge, Md. Bought in Durham, N. C. Salicylic acid was found.

1324 *Globe Brand Sugar Corn, Finest Quality.*—Curtice Canning Co., Rochester, N. Y. Packed at Vernon, Oneida Co., N. Y. Bought in Durham, N. C. Salicylic acid was found.

1325 *Gold Cord Sweet Corn. First Quality. Sweet and Tender.*—Packed by A. V. Lane, Tabery, Oneida Co., N. Y. Bought in Durham, N. C. Salicylic and sulphurous acids were found.

1326 *Johnson Brand Tomatoes.*—Packed by J. B. Johnson & Co., Blades, Del. Bought in Durham, N. C. Salicylic acid was found.

1327 *The Wayside Inn, Coreless Sliced Pineapples.*—Packed by Thurber, Whyland & Co., New York. Bought in Durham, N. C. This sample contained a very large amount of salicylic acid.

1328 *Queen's Taste Sweet Corn.*—Packed by Wilson, Burns & Co., Baltimore, Md. Bought in Durham, N. C. Salicylic and sulphurous acids were found.

1329 *Wilkes Brand Blackberries.*—Packed by the Brushy Mountain Canning Co., North Wilkesboro, N. C. Bought in Greensboro, N .C. Salicylic and sulphurous acids were found.

1330 *My Wife's Best Baked Pork and Beans.*—Packed by Mrs. Sydney Arnold, no address given. Bought in Greensboro, N. C. Salicylic acid was found.

1331 *Virginia Standard Tomatoes.*—Packed by C. M. Nalls, Amsterdam, Va. Bought in Greensboro, N. C. Salicylic acid was found in fairly large quantity.

1332 *Early June Peas. . .Baltimore Oriole Brand.*—Packed by

Somers Foote & Co. No address given. Bought in Greensboro, N. C. Salicylic acid was found.

1333 *Piedmont Beauty Brand Blackberries.*—Packed by Edwards & Stone, Kernersville, N. C. Bought in Greensboro, N. C. Salicylic acid was found.

1334 *Choice Blackberries.*—Packed by Edwards & Stone, Kernersville, N. C. Bought in Greensboro, N. C. Salicylic acid was found.

1335 *Pocahontas Fancy Sugar Corn. Solid Packed.*—Packed by the Taylor and Bolling Co., Richmond, Va. Bought in Greensboro, N. C. No preservative was found.

1336 *Early June Peas. . . Seldom Equalled, Never Excelled.*—Packed and guaranteed by J. S. Farren & Co., Baltimore, Md. Bought in Greensboro, N. C. Salicylic acid was found.

1337 *Standard Peaches. First Quality.*—Grown and packed by Gilmer & Smith, Greensboro, N. C. Bought in Greensboro, N. C. Salicylic acid was found.

1338 *Van Camp's Pork and Beans, with Tomato Sauce.*—Packed by Van Camp Packing Co., Indianapolis, Ind. Bought in Greensboro, N. C. Salicylic acid was found.

1339 *Snap Beans.*—Packed by Henry Hunter, Greensboro, N. C. Bought in Greensboro, N. C. No preservative was found.

1340 *Fresh First Quality Apples.*—Packed by Hugenot Canning Co., Hugenot, Va. Bought in Greensboro, N. C. Salicylic acid was found.

BULLETIN NO. 166 JUNE 15, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

Butter

Its Composition, Artificial Imitation and Adulterants.

Butter Adulteration in North Carolina.

W. A. WITHERS AND J. M. PICKEL.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q HOLLADAY. LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E EMERY M.S., Agriculturist.*
W F. MASSEY, C.E., Horticulturist *
COOPER CURTICE, D.V.S., M.D., (1) Veterinarian.*
G. S. FRAPS, Ph.D., Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES, Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist.
J. M. JOHNSON, M.S , Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B S., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR. A.M., State Chemist.
C. B. WILLIAMS, M.S , Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY. Assistant Chemist.
W. G. HAYWOOD. B.LITT., Assistant Chemist.
H. E. KING. Chief Clerk.
MISS M. S. BIRDSONG. Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

* Member of Station Council.
(1) On leave of absence.

BUTTER.

W. A. WITHERS, A. M., CHEMIST.
J. M. PICKEL, PH. D., ACTING ASSISTANT CHEMIST.

This BULLETIN is the seventh of the series containing the results of the investigations planned by the chemist relating to the adulteration of human foods. The analytical work in this bulletin was performed by Dr. Pickel who also assisted in the preparation of the matter of the bulletin.

INTRODUCTION.

On January 1st, 1899, North Carolina had 248,263 milch cows, which were valued at $3,947,382, or $15.90 a head (1). At the same time Connecticut had 143,098 milch cows, valued at $5,087,134, or $35.55 a head (1). This difference in valuation is doubtless due, in part, to the fact that all products of the living animal (milk, butter, cheese, manure) and all parts of the slaughtered (flesh, tallow, oil, hair, hide, hoofs, horns, bones, etc.,) are in greater demand and command higher prices in a thickly settled, manufacturing community than in a sparsely settled agricultural one. In the year 1890 Connecticut had 127,892 milch cows which produced 10,369,259 pounds of butter, or about 81 pounds per head (2). During the same year according to the U. S. census report, North Carolina had 223,416 milch cows and produced 13,129,374 pounds of butter or about 59 pounds per head. At that rate per head, the North Carolina cows of 1899 would have produced 14,573,038 pounds, worth, at 20 cents a pound, $2,914,607. (The retail price of butter the past winter in Raleigh was 25 to 30 cents.) These figures are not accurate but they are doubtless very near the truth. It is to be regretted that the product is not much greater. Presumably North Carolina exports practically no butter; but that she imports a great deal, any one may convince himself by asking at the grocery stores the question, "Where does your butter come from?" How much of this imported article is genuine butter, how much artificial, no one knows. Of the seventeen samples tested and reported in this bulletin, one was oleomargarine pure and simple.

It is the purpose of this bulletin to give a brief account of the following matters: (1) Chemical composition of animal fats, with a view to bringing out the distinctive features of butter; (2) Manufacture of oleomargarine or artificial butter; (3) Adulterants of butter and their detection; (4) Adulteration of butter in North Carolina. These subjects are gone into only so far as, it is thought,

(1) Statistician U. S. Dept. of Agriculture. (2) Eighth Report of Conn. Dairy Commission, 27.

it will interest the general reader. Some technical and scientific terms are used, but their meaning and application are explained. It need hardly be stated that by "butter," is meant the butter of the cow; though butter may, of course, be made, and in some cases of excellent quality, from the milk of other animals.

I. The Chemical Composition of Animal Fats.

Our knowledge of the composition of these substances dates from the researches of the distinguished French Chemist, Chevreul, who, it may be stated in passing, died in Paris in 1889, at the advanced age of one hundred and three years, lacking a few months. Investigations of the subject, begun by him as early as 1812, brought out the fact that animal fats and oils are mixtures, in varying proportions, of a class of compounds which chemists at the present day designate as *esters*. The names of the more common of these esters are: Tri-stearin, Tri-palmitin, Tri-olein, Tri-butyrin.

In writing of these esters, we shall for convenience, drop the prefix tri.

Stearin is a white, tasteless, odorless, soft solid, lighter than water, melting when pure at 161 degrees F. It is the main constituent of stearin candles. Palmitin is very similar to stearin, but melts at a lower temperature, 145 degrees F. Olein is a liquid at ordinary temperatures, and is without color, odor or taste. Butyrin is likewise a liquid at ordinary temperatures; and quite similar and allied to it are the esters, caproin, caprin, caprylin.

The common animal fats and oils are composed of the first three esters in varying proportions. It can readily be understood how an admixture of a large percentage of the solids, stearin and palmitin, with a small quantity of olein would result in a solid, such as tallow; a larger admixture of olein, in a semi-solid, such as lard; a still larger admixture of olein, with the stearin and palmitin would form an oil. Beef tallow consists mainly of stearin with small quantities of palmitin and olein; mutton fat contains slightly less of stearin and palmitin. Neats-foot oil consists mainly of olein with little stearin. Olive oil is chiefly olein and palmitin, the former in large proportion. Cotton-seed oil contains considerable stearin (25 to 30 or more per cent), some palmitin, much olein and some linolin. This latter ester is not found in animal fats. It is the characteristic constituent of *drying oils* (of which linseed oil is the chief), oils of this class absorb oxygen from the air, and become hard or glazed, forming varnish. In this regard cotton-seed oil is classed among *semi*-drying oils.

But what about butter? Does it contain any of the tallow-like stearin and palmitin of other animal fats; and if so, wherein does its composition differ from that of the others? Over fifty per cent of butter fat consists of stearin and palmitin. Dr. Wiley, chief chemist of the U. S. Department of Agriculture, gives the following as the composition of a good butter fat:

Butyrin	7.00 per cent.	Not found in other common fats.
Caproin, Caprin, Caprylin	2.30 " "	
Olein	37.70 " "	Main constituents of other common fats.
Stearin, Palmitin	53.00 " "	

Butter fat, therefore, differs from other common animal fats in that it contains about nine per cent of butyrin and allied esters, not found in the other fats. Each of these esters is composed of glycerin on the one hand and of certain acids, palmitic, stearic, oleic, butyric, etc., on the other. The characteristic acids of butter, that is those found in butter but not in other common fats, are volatile, i. e., when boiled with water they are volatilized and pass off with the steam. The other acids of butter and the acids of the other common fats are not thus volatile. And this fact is of the highest importance, as will be seen later, in testing butter for adulteration with foreign fats.

Butyric acid, which constitutes by far the larger part of the characteristic butter acids, is a thick liquid of an exceedingly disagreeable, rancid smell. It was discovered in 1814 by Chevreul. It has been observed to exist in the uncombined state in flesh extract and in perspiration. It is formed in the decomposition (decay) of albuminous substances. The chief means of preparing it is by butyric fermentation of sugar, starch or lactic acid.

A word as to the flavor and aroma of good butter. The agreeable and highly prized flavor and aroma of good butter are due to the combined effect of many constituents, but especially to the glycerides and other esters, or ethereal salts of the volatile acids. It is an interesting and striking fact of nature that often substances which, like butyric acid, are in themselves repulsive, become in combination most agreeable. If a mixture of butyric acid and alcohol are shaken up with sulphuric acid, a chemical action is brought about between the two former, whereby is produced a highly aromatic ester, or ethereal salt, similar in odor to pineapple essence. And this is but an example of a large number of compounds, found in nature or made by the chemist's art. The flavor and aroma of butter are due to these ethereal products, many of which are present in such small quantities as not to be measurable. And whether the flavor and odor be agreeable or the contrary, depends on the kind of esters present; and this in turn depends on many factors, among them on the kind of bacteria concerned in the ripening of the cream from which the butter is made. One of the most important advances in recent dairy practice, a striking example of the application of science to practical matters, an advance due to the agricultural experiment stations, was the discovery that the ripening of cream (and also of cheese) is due largely to the growth in the cream of innumerable plants, or bacteria, so small that they can be discovered only by the aid of the finest microscopes. Some kinds of these bacteria produce agreeable odor

and flavor, other kinds indifferent or disagreeable odor and flavor. If a butter is lacking in flavor and aroma, or the flavor and aroma are unpleasant, that means that the deleterious bacteria gained the upper-hand in the ripening of the cream. It is, therefore, important to be able to distinguish and separate the beneficial from the deleterious bacteria, to know the conditions which favor the growth of each, to cultivate the beneficial and weed out, so to speak, the deleterious. This knowledge has, to large extent, been acquired, and it is becoming possible for the dairyman to plant in his cream the desired kind of bacteria, thus with proper management insuring his butter's having a highly agreeable aroma and flavor. A pure culture of yeast which with proper management insures the baker and the house-wife's making a good, light, wholesome bread, is now a regular article of commerce. In a somewhat analogous manner, pure cultures of bacteria of the desired kind are beginning to be put on the market for the use of dairymen.

What has thus far been stated regarding the composition of butter applies to the *fat* only. In addition to the fat, butter contains other important constituents, namely, casein (or curd), milk-sugar, mineral matter, water, and traces of other substances. The relative quantities of fat and of those constituents vary within considerable limits, depending, among other things, on the breed of cow, kind and quantity of food, period of lactation, and manipulation of the butter. Koenig, the leading German authority on foods, states that a good, normal, unsalted butter has about the following composition: (For purpose of comparison the minimum, maximum and average composition of 123 samples of market butter is given; these analyses are also taken from Koenig.)

	Normal unsalted Butter.	Market Butter.		
	Average.	Minimum	Maximum	Average.
	Per Cent.	Per Cent	Per Cent	Per Cent.
Fat	87.0	76.37	85.25	83 27
Casein	0.5	0.19	4.74	0.71
Milk Sugar	0.5	0.85	1.16	0.58
Mineral Matter	0.3	0.06	5 65	0.95
Water	11.7	5.50	35.12	14.49

Wing, an American authority on dairy products, gives the following as about the composition of a good butter (salted). The average composition of four samples of oleomargarine, or artificial butter, as given by Koenig, is placed along side for comparison.

	Normal (salted) Butter, according to Wing.	Oleomargarine, Average of four samples.
	Per Cent.	Per Cent.
Fat	85 (contains about 9 per cent of volatile acids).	87.16 (contains no volatile acids).
Casein	1	0.43
Salt	3	2.08
Water	11	10 33

As has been pointed out, fat is a mixture of glycerides, (the esters of glycerin are thus designated), butter fat differing from other common fats in that it contains about nine per cent of glycerides of butyric and allied volatile acids, not found at all, or else to only very limited extent, in other fats. Oleomargarine contains only so much of these volatile acid glycerides—hardly one per cent—as is added in process of manufacture. In regard to elementary composition, the glycerides consist of carbon, hydrogen and oxygen. In addition to those elements, casein contains, in the main, nitrogen; in its general value as food, it is analogous to white of egg, beef steak and other nitrogenous foods, whose office is to form the muscles, tendons, tissues, blood, etc., of the body. Fats, in common with sugars, starch and cellulose, play, in nutrition, the part of heat producers, supply warmth to the body, and prevent the undue consumption (for warmth production) of nitrogenous foods. Whether, or not, the fat of butter has greater nutritive value than other common fats, is a question. The relative probable digestibility of some of the common fats, as compiled by Atwater, is as follows: Butter 96 per cent, oleomargarine, tallow, lard, oils, 95 per cent each (1). Recent experiments by H. Luehrig (2), a German investigator, found the digestibility of three samples of oleomargarine, bought on the market, to be 96.7 to 96.93 per cent, and that of Holstein dairy butter to be 95.96 per cent. The experiments were carried out on a strong, healthy man, 29 years old, possessed of sound normal digestion. From these figures, it would seem that there is no great difference in the digestibility of the two. This does not touch the question (on which experimental data are not at hand) of the *"ease of digestion."* Equal quantities of two nutrients may be digestible; but the digestion may require the expenditure of so much more energy, labor, on the part of the digestive organs in the one case than in the other, as to render the nutrients quite unequal in food value. Then there is the matter of individual peculiarities; what one person can digest easily another

(1) Chemistry and Economy of Food, page 70.
(2) Chem. Cent. Blatt., 1899, Bd. II, 215.

may digest with difficulty or not at all perhaps. The heat producing power of several common fats is given by Atwater as follows (1):

Fat of swine	9380	calories	or	units.
Fat of oxen	9357	"	"	"
Fat of sheep	9406	"	"	"
Butter fat	9192	"	"	"

According to this showing the heat producing power of butter is somewhat less than that of the other common fats.

II. Manufacture of Artificial Butter.

The manufacture of oleomargarine or artificial butter has, in various parts of the world, reached large proportions. In the United State alone, there were produced, in 1894, according to Brannt (2) 69,622,246 pounds, of which 3,406,058 pounds were exported. The production by States, as given by the same authority, was:

Illinois	41,000,000	pounds.
Kansas	10,000,000	"
Connecticut and Rhode Island (over)	6,000,000	"
Nebraska	3,475,?50	"
Ohio (over)	3,000,000	"

It pays a tax of two cents a pound.
In 1898 there was exported—

Butter, 25,690,025 pounds, value	$3,864,765[2]
Oleo oil, 132,579,277 pounds, value	7,904,413
Oleomargarine, 4,328,536 pounds, value	386,297

The manufacture of oleomargarine originated in France. Napoleon III is said to have expressed a wish for a cheap, nutritious substitute for butter, suitable for the use of sailors and the poor. Acting on this suggestion, Mege-Mouries, a French chemist, devised and patented in 1869 a process of converting beef fat into a butter substitute, and began its manufacture the same year. Since then many patents on the same subject have been taken out in various parts of the world; but in their fundamental features the various processes are very similar to the original French method.

Among the materials used in its manufacture are beef tallow, lard and cotton-seed oil stearin. Taking beef tallow as the starting point and remembering that it differs from butter in its larger content of the solid glycerides, stearin and palmitin, and in having none of the volatile acid glycerides, it is readily seen that the task of converting it into a product resembling butter consists mainly of two steps, viz.: removing the excess of solid glycerides and adding to this product a quantity of the glycerides of butyric and allied acids. The manufacture as actually carried out may be stated in three main steps: (1) freeing the crude fat from tissue (in common farm-house language, this is known as "rendering"); (2) removing a portion of the solids, stearin and palmitin; (3) giving the product, thus formed,

(1) Chemistry and Economy of Food, page 127.
(2) Yearbook, 1898, U. S. Department of Agriculture.

a butter odor and flavor by churning it up with cream, milk or both, and sometimes with a portion of genuine butter.

To free the fat from a portion of the solid glycerides, it is wrapped in small parcels in bags of canvas, subjected to hydraulic pressure and, while in the press, is heated up to a sufficient temperature to allow the olein (which carries with it a portion of stearin) to be squeezed out. This product, the oleo-oil, is not at ordinary temperature liquid, but has the consistency of butter, and like it melts in the mouth, but is comparatively flavorless. After it has been churned with cream or milk, or a portion of butter, a more or less marked butter flavor and aroma are imparted to it; but the quantity of butyrin and other glycerides, peculiar to butter, that it thus acquires, is small. Whereas genuine butter of good quality contains about nine per cent of these glycerides, oleomargarine will contain hardly one per cent. The fact that it contains so little of these easily decomposible volatile acid glycerides renders it less liable to spoil than butter. When properly made from good materials, it is, no doubt, a wholesome, nutritious food.

A striking feature of modern manufactures is that nothing is allowed to go to waste; along side of the main article of manufacture, a number of "by-products" will generally be worked up into merchantable form. It is to this utilization of what would otherwise be "wastes," that modern low prices are in part due. The manufacture of artificial butter furnishes a striking example of the working up of by-products. An Austrian oleomargarine factory makes, according to Brannt, the following statement on this point: One ox yields about 182 pounds of crude fat, from which are produced about 40 pounds of oleomargarine; 52 pounds of stearic acid (marketed mainly as candles); 52 pounds of oleic acid (worked up into soap); 6 pounds of glycerin; and 36 pounds of dry scrap (utilized as fertilizer).

III. Butter Adulterants.

Earthy matter, such as chalk, gypsum, heavy spar, is reported to have been met with as adulterants, but is unsuitable for the purpose and rare. Starch and potato meal are more frequent. Artificial coloring is well-nigh universal. Curd, salt and water are, when in excess, to be regarded as adulterants. Excessive salting is common, though tastes differ as to what is excessive salting. In South Germany and Switzerland butter is not salted. Excessive quantities of curd and water are frequently purposely left in butter by not properly working out the buttermilk. But the most important adulterant is foreign fats, more particularly oleomargarine, and it is to this that attention was directed in the examination of the samples reported in this bulletin. A good judge of butter may, as a rule, be able, by means of flavor, odor and general appearance, to distinguish oleomargarine from genuine butter. But in those cases where the butter is mixed with oleomargarine up to 10, 15 or 20

or possibly greater, per cent, the matter is by no means so simple. It is altogether possible for a mixture of this kind to be superior in aroma, taste and wholesomeness to much of the real, but low grade, butter put on the markets. Chief among the means of detecting foreign fats in butter, are the following:—difference in shape of the crystals of butter and of other fats; the different ways in which these crystals (also the molten fats) affect a beam of light when passed through them; differences in melting point; differences in specific gravity; saponification value; volatile acid value. A word of explanation in regard to the two latter will be interesting to the general reader.

By *saponification value* is meant the quantity of alkali necessary to convert a given quantity of fat into soap. This value ranges from 193 to 200 for beef tallow, 195 to 197 for lard, 192 to 200 or 206 for oleomargarine. In the case of butter, this value may go as high as 232 or possibly a little higher; and recently a genuine butter was reported from Germany with a saponification value of only 216.2 (1). The average has been placed at about 227. The official agricultural chemists of the United States say that, if this number falls below 220, the butter is to be condemned as adulterated. But the rule must be applied with caution.

In a preceding part of this bulletin, the meaning of the terms *"volatile acids,"* as used in connection with fats, has been explained. By the *"volatile acid value* or *number,"* of a fat, is meant the quantity of alkali required to neutralize the acids volatilized, under certain standard conditions, from a fixed quantity (5 grams, or about one-sixth of an ounce) of the fat. This value for beef tallow and for lard has been found (or thought to be found) at 0.25 and 0.68 respectively; for oleomargarine 0.33 to 1.43 have been found. In the case of genuine butter this value goes sometimes as high as 32 to 33 and in rare cases falls below 20; the average has been placed at about 28. The German butter above referred to as having an abnormally low saponification value, had also an abnormally low volatile acid value, 19.3. The Alabama Experiment Station reported some years ago 21.9 as the volatile acid value of a butter made from the combined cream of ten cows and 19.2 as the value of that made from one cow. These results were obtained in a series of experiments carried on to ascertain the effect on butter of feeding cotton-seed meal, as part of the ration, to cows. The conclusion reached was that coton-seed meal lowers the volatile acid value and raises the melting point of butter. Linseed cake also lowers the volatile acid value.

The official agricultural chemists of the United States lay down this rule:—butter whose volatile acid value is as low as 25 is to be regarded as suspicious; if this value falls to 23 or less, the butter is to be condemned. Undoubtedly a considerable quantity of oleomar-

(1) Chem. Cent. Blatt, 1899, Bd. I, 507.

garine, or other foreign fat, might be incorporated with a genuine butter of high volatile acid value, without depressing the volatile acid value of the mixture below 25. And it is evident from what is said above, that to condemn outright as adulterated a butter whose volatile acid value is as low as 23 would not be safe. In cases of this kind all known means of testing for adulterants are to be applied; and usually one or another, or the combined evidence of all will decide the matter for or against the butter.

IV. Butter Adulteration in North Carolina.

The samples (see table below) examined for foreign fats and reported on here, were, with two exceptions, bought in the open market, as follows:—one from a countryman, ten at Raleigh groceries, four in Durham. Two samples were from the college dairy. Eleven of the samples were imported into the State; the rest were home or country butter. The price paid for the butter was 25, 27 and 30 cents a pound. Of only one of the samples, namely No. 1344, can it be positively stated that it was not butter; it was oleomargarine, and was sold at 27 cents a pound. Several other samples were of doubtful character, that is, may have contained foreign fats; an examination of their optical properties might have cleared up the doubt.

RESULTS IN DETAIL.

Number of Analysis.	Description, Brand, etc.	Price per Pound.	Specific gravity at 100°; water at 100° as unit.	Volatile Acid. Value.	Saponification. Value.
		Cents.			
1308	† Illinois Creamery Co. Elgin, Illinois.	30	0.9000	27.5 26.7	232.0 232.6
1309	† "Northern butter"	25	0.8999	28.6	230.9 229.7
1310	† Country butter	25	0.8973	29.7 29.9	227.7 227.5
1311	† "Northern butter"	30	0.8998	28.0 26.5	227.6
1312	† Fox River Butter Co. Aurora, Illinois.	30	0.9007	29.5 30.5	229.2 230.4
1313	† Goshen butter New York.	30	0.8996 0.9001	27.3	227.4 225.7
1314	† Kay & Co. New York.	30	0.8987 0.8982	27.5 27.3	227.7 226.0
1315	† Lawn Spring Creamery New York.	30	0.8981 0.8975	23.9 24.0	231.4 230.6
1316	† College Dairy, A. & M. College	......	0.8994 0.8995	29.0 27.8	227.1 225.5
1317	† College Dairy, A. & M. College	......	0.8997 0.8992	29.8 30.3	227.8 226.9
1344	* White Clover, Elgin Butter Co. Elgin, Illinois.	27	0.8940 0.8931	1.0 1.3	192.7 193.1
1345	* Cloverdale Creamery New York.	27	0.9003 0.9002	26.3	225.3 226.1
1346	* Fresh Jersey, Occoneeche Farm North Carolina.	30	0.8999 0.8985	24.1 25.1	226.9
1347	* Wilkins & Co. Washington, D. C.	25	0.8999 0.9002	25.2 24.4	228.4 228.1
1351	† Country butter, Prof. F. E. Emery Raleigh.	......	0.8974 0.8987	25.0 24.3	223.9 223.4
1354	† Sweet Clover, T. H. Legett & Co. New York.	25	0.9007	23.7 23.5	226.6
1355	† Premium, T. H. Legett & Co. New York.	30	0.9001	25.2 25.9	226.4

† Procured in Raleigh. * Procured in Durham.

BULLETIN NO. 167 *JUNE 30, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

Poultry Experiments

During the Year 1898-'99.

F. E. EMERY, M.S.

RALEIGH, N. C.

*Delayed in preparation.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E. EMERY, M.S., Agriculturist.*
W. F. MASSEY, C.E., Horticulturist.*
COOPER CURTICE, D.V.S., M.D., (1) Veterinarian.*
G. S. FRAPS, Ph.D., Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist.
J. M. JOHNSON, M.S., Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B.E., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M., State Chemist.
C. B. WILLIAMS, M.S., Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY, Assistant Chemist.
W. G. HAYWOOD, B.LITT., Assistant Chemist.
H. E. KING, Chief Clerk.
MISS M. S. BIRDSONG, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

* Member of Station Council.
(1) On leave of absence.

TABLE OF CONTENTS.

LETTER OF TRANSMITTAL.

THE N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE N. C. AGRICULTURAL EXPERIMENT STATION.

DIVISION OF AGRICULTURE.

RALEIGH, N. C.

SIR: I have the honor of presenting this manuscript, which is recommended to be published as a bulletin from the Poultry Section of this Division of the Station for the fiscal year 1898-'99.

The poultry interests are scattered throughout the State. No citizen is wealthy in poultry holdings, but no one is too rich or too poor to own and be interested in a flock of chickens. Thus from their presence on every farm and in every hamlet they are of great importance to all the people, supplying a large proportion of the best food and furnishing a remunerative employment for more people perhaps than the so-called manufacturing interests of the State.

The total income from poultry is very large. It is not easy to measure by statistical yardstick, because it is at hand and in everyday use, and very few people put themselves to the trouble of counting *the eggs or broilers used at home*. Those sold make a long line of figures which compares well with that for any other industry engaged in by the people of North Carolina.

We trust the facts and presentations herein made may lead to more economical production of chickens and eggs.

Respectfully submitted,

FRANK E. EMERY,
Agriculturist.

To the Acting Director.

POULTRY EXPERIMENTS FOR THE YEAR ENDING JUNE 30, 1899.

By F. E. Emery, M. S., Agriculturist.

I. CLASS VS. CLASS AND BREED VS. BREED.

The final deductions in this test for the first six months of 1899 have been reduced to individual results per month as nearly as possible.

There are only three yards of the Mediterranean class against seven of American, and six of the Asiatic fowls.

These birds have been fed as nearly as possible to the rules given in article III, and the practice makes the writer satisfied the system will be satisfactory in general.

The changes are regular, except those of bone, and that depends on the market. All other details can be foreseen and provided for to a nicety.

A. Mediterranean Class.

1. *Black Minorca Pullets.*

   Produced per hen, 43.31 eggs; cost, 37.87 cents for food; market value, 45.72 cents. Value of eggs in per cent. of cost of food, 120.7.

2. *Single Comb Brown Leghorn Pullets.*

   Produced per hen, 77.43 eggs; cost, 29.21 cents for food; market value, 82.64 cents. Value of eggs in per cent. of cost of food, 282.9.

3. *Single Comb Brown Leghorn Hens (2 Yrs. Old).*

   Produced per hen, 67 eggs; cost, 38.91 cents for food; market value, 70.33 cents. Value of eggs in per cent. of cost of food, 180.75.

4. Two yards of pullets and one of hens (2 years old).

   Produced 11.04 eggs per month and per hen at a cost of 6.24 cents; market value of eggs, 11.69 cents.

This amounts to 187.5 per cent. based on cost of food alone. No hens of this class have taken any part in incubation.

B. American Class.

1. *Barred Plymouth Rock Pullets.*

Produced per hen, 79.87 eggs; cost, 59.32 cents for food; market value of eggs, 86.29 cents. Value of eggs in per cent. of cost of food, 145.46.

2. *Barred Plymouth Rock Hens (2 Yrs. Old).*

Produced 59.11 eggs; cost, 72.33 cents for food; market value of eggs, 63.74 cents. Value of eggs in per cent. of cost of food, 88.12.

3. *Barred Plymouth Rock Hens (Coming 2 Yrs. Old, Late Hatched).*

Produced 81.54 eggs; cost, 53.4 cents for food; market value of eggs, 87.08 cents. Value of eggs in per cent. of cost of food, 163.75.

4. *White Plymouth Rock Pullets.*

Produced 64.13 eggs; cost, 55.4 cents for food; market value of eggs, 66.96 cents. Value of eggs in per cent. of cost of food, 120.87.

5. *Silver Laced Wyandotte Pullets.*

Produced 80.21 eggs; cost, 39.75 cents for food in five months; market value of eggs, 85.02 cents. Value of eggs in per cent. of cost of food, 213,89.

6. *White Wyandotte Pullets.*

Produced 70.2 eggs; cost, 37.14 cents for food; market value of eggs, 74.25 cents. Value of eggs in per cent. of cost of food, 199.92.

7. *White Wyandotte Hens.*

Produced 40.57 eggs; cost, 49.35 cents for food; market value of eggs, 43.54 cents. Value of eggs in per cent. of cost of food, 88.23.

8. Four yards of pullets and three yards of hens produced per individual and per month 11.6 eggs at a cost of 8.94 cents; market value of eggs, 12.36 cents.

This amounts to 138.26 per cent. based on cost of food alone for all yards of pullets and hens named above in the American class.

Hens of each breed, including pullets of each breed, have borne their proportional share of incubation.

C. Asiatic Class.

1. *Buff Cochin Pullets.*

    Produced 17.76 eggs in 2 3-5 months; cost, 18.39 cents for food; market value of eggs, 17.76 cents. Value of eggs in per cent. of cost of food,96.61..

2. *Buff Cochin Hens.*

    Produced 58.2 eggs; cost, 64.00 cents for food; market value of eggs, 61,28 cents. Value of eggs in per cent. of cost of food, 95.75.

3. *Black Langshan Pullets.*

    Produced 88.2 eggs; cost, 53.41 cents for food; market value of eggs, 93.8 cents. Value of eggs in per cent. of cost of food consumed, 175.62.

4. *Black Langshan Hens (2 Yrs. Old).*

    Produced 72.07 eggs; cost, 66.12 cents for food; market value of eggs, 75.86 cents. Value of eggs in per cent. of cost of food, 114.73.

5. *Light Brahma Pullets.*

    Produced 102.06 eggs; cost for food, 84.96 cents; market value of eggs, 106.95 cents. Value of eggs in per cent. of cost of food, 125.88.

6. *Light Brahma Hens.* Aged or Unknown.

    Produced 30.56 eggs; cost, 61.18 cents for food; market value of eggs, 30.89 cents. Value of eggs in per cent. of cost of food, 50.49.

7. Three yards of pullets and three yards of hens produced 11.3 eggs per individual and per month at a cost of 10.68 cents; market value of eggs, 11.86 cents.

This amounts to 111.05 per cent. based on cost of food alone for all yards in this class of fowls.

8. This class has voluntarily assumed more than proportional share of incubation. The Buff Cochins, especially, have suffered by deaths while sitting.

Light Brahmas and Barred Plymouth Rocks have lost apparently from single birds becoming overfat in yards where others have not maintained standard weights.

Buff Cochin pullet yard was broken up by the number of deaths, and the sudden death of the cock in that yard. After April 19th

the remaining pullets were added to the remaining hens in the yard of Buff Cochin hens, and the record continued as Buff Cochin hens.

The White Plymouth Rock pullets have shared their large yard with ducks. This yard is without trees, hence there are less insects in it, and they are in a measure set back by this environment.

The Black Minorca pullets have had a rather restricted range, as have also the Silver Laced Wyandotte pullets, and to a much less degree both White Wyandotte pullets and hens.

With these exceptions the comparisons seem fair to all breeds and yards. There is, however, a seeming excessive cost for food to Light Brahma pullets, yet, it does not appear to be wrong, though there might be an overcharge there.

The considerable number of fowls handled, and several changes having necessarily been made in assistants in charge of the work of feeding and moving fowls, make it impossible to affirm absolute accuracy in the minute details, hence all tables are marked E and O E for errors and omissions excepted.

With a skillful feeder and careful note-taker in charge of the work these errors are trifling. The most serious error consists in charging all the food used and consumed to the fowls, when there is an army of sparrows (*passer domesticus*) which feeds with the fowls, and to abate which no adequate means have yet been devised.

Conclusion and Recapitulation.

Number of eggs per month per hen:

American Class............ 11.6
Asiatic Class................ 11.3
Mediterranean Class......... 11.04

Lowest monthly cost of production:

Mediterranean Class.... 6.24 cents
American Class......... 8.94 cents
Asiatic Class..........10.68 cents

Highest gain in value of eggs above value of food to yards: *(a)* based on number of eggs at 13½ cents per dozen; (*b*) based on same price and weight of 17.5 ounces equivalent to a dozen. (See article IV.)

(*a*) Mediterranean Class....87.50 per cent.
American Class........38.26 per cent.
Asiatic Class..........11.05 per cent.

This results from the difference in the cost of food as well as in number of eggs.

(*b*) Mediterranean Class..........147.12
American Class...............199.35
Asiatic Class..................168.35

That is if Brown Leghorn pullet eggs are worth $13\frac{1}{2}$ cents per dozen for 17.5 ounces, then are Brown Leghorn hen eggs worth 16.3 cents and Black Minorca pullets' eggs 19.9 cents. The average monthly product of this Mediterranean class becomes, therefore, 15.92 cents for 20.64 ounces of eggs produced at a cost of 6.24 cents, which is 147.12 per cent. above cost for food.

By the same method the eggs produced per month by the average hen or pullet in the American class is found to be worth 17.83 cents for 23.11 ounces of eggs.

The per cent. of gain above cost of food 8.94 cents is 99.44.

The eggs produced by the average hen of the Asiatic class is found to be worth by the same rates 17.98 cents per month for a cost of 10.68 cents, which is 68.35 per cent. above the cost for food.

II. BREED VS. BREED.

By the above there is difference enough shown between classes, so this comparison might be made between breeds within each class. It has been shown (p. 394) that the Black Minorca pullets have had a restricted range. They, therefore, have not laid as they would have done under more favorable circumstances; so in awarding the palm within this class to the Single Comb Brown Leghorn breed it is only just to say that they have the name here, in default of fair competition. The Brown Leghorns have been well, hearty non-sitting, and *have not laid so many eggs* per individual as have several yards in other classes. They gain their laurels by virtue of their light weight and low cost for food.

But we make the comparison more fully below:

Comparisons are robbed of some of the force by several breeds not having representatives in the mature class. However, they can be compared in the pullet class.

Name of Breed.	Number of Eggs Produced per Month and per Hen.	Cost of Eggs Produced per Month and per Hen for Feed.	Value of Eggs Produced per Month and per Hen, Based on Numbers and Market Price Alone.	Value of Eggs Produced per Month and per Hen, Based on Weight per Article IV.	Weight of Eggs Produced per Month and per Hen.
		Cents.	*Cents.*	*Cents.*	*Ounces.*
PULLETS—*Mediterranean Class:*					
Black Minorca	8.662	7.574	9.144	14.76	19.13
Single Comb Brown Leghorn	12.905	4.87	13.773	14.52	18.82
PULLETS—*American Class:*					
Barred Plymouth Rock	13.31	9.889	14.38	20.94	26.84
White Plymouth Rock	10.69	9.23	11.13	16.22	21.03
White Wyandotte	11.70	6.19	12.375	17.52	23.01
Silver Laced Wyandotte	16.04	7.678	17.004	22.79	29.54
PULLETS—*Asiatic Class:*					
Buff Cochin	6.83	7.07	6.83	10.58	13.72
Black Langshan	14.70	8.90	15.63	22.77	29.52
Light Brahma	17.01	14.16	17.825	25.59	33.17
HENS:					
Single Comb Brown Leghorn	11.17	6.485	11.72	15.58	20.2
Barred Plymouth Rock (2 years)	9.852	12.055	10.607	16.59	21.51
Barred Plymouth Rock (late hatched, 2 years)	13.59	8.9	14.51	20.52	26.61
White Wyandotte	6.76	8.225	7.257	10.214	13.24
Buff Cochin	9.71	10 67	10.21	14.73	19.09
Black Langshan	12.01	11.02	12.643	20.53	26.61
Light Brahma	5.093	10.197	5.15	9.17	11.884

As far as this record goes it shows that for high production, weight of eggs produced, as well as for economy in production, pullets far outstrip hens. Young, vigorous stock is best stock to keep.

The greatest production of eggs from pullets have been made in this order, Light Brahma, Silver Laced Wyandotte, Black Langshan, Barred Plymouth Rock and Single Comb Brown Leghorn. White Wyandotte, White Plymouth Rock, Black Minorca and Buff Cochin at the foot of this list.

Among the hens late hatched Barred Plymouth Rock leads, with Black Langshan and Brown Leghorn, followed by Barred Plymouth Rock and Buff Cochin, in this order. White Wyandotte and Light Brahma foot the list.

The greatest production of weight of eggs brings the birds in a little different order.

Among the pullets this order is: Light Brahma, Silver Laced

Wyandotte, Black Langshan, Barred Plymouth Rock, White Wyandotte and White Plymouth Rock, with Black Minorca, Leghorns and Buff Cochins last.

In production of weight of eggs no hens were equal to the pullets of the same breed, except Brown Leghorn and Buff Cochin, and these were the poorest producers of weight of eggs.

Now to change from numbers and weight of eggs produced to economy of production a marked difference will be noted.

This phase may be shown best by percentage of value, market value for numbers, slightly varied by the time eggs were received, the January and June eggs having brought one-fourth of a cent each more than the other months, and intrinsic value as calculated from a standard weight and compared with cost of food for the breed.

	Per Cent of Market Value of Eggs Produced above Cost of Food.	Per Cent of Value of Eggs Produced by Weight above Cost of Food.
PULLETS:		
Single Comb Brown Leghorn	182.8	198.2
Silver Laced Wyandotte	113.9	196.8
White Wyandotte	99.9	183.1
Black Langshan	75.6	155.8
Barred Plymouth Rock	45.5	109.4
Light Brahma	25.9	80.7
Black Minorca	20.7	94.9
White Plymouth Rock	20.9	75.8
Buff Cochin	—3.4	49.9
HENS:		
Single Comb Brown Leghorn	80.8	140.2
Barred Plymouth Rock (late hatched)	63.8	130.6
Black Langshan	14.7	86.3
Buff Cochin	—4.2	38.1
Barred Plymouth Rock	—11.9	37.6
White Wyandotte	—11.8	24.2

The leading breeds in this comparison are Brown Leghorn, Barred Plymouth Rock (counting the late hatch hens only), Black Langshan and White Wyandotte. If Silver Laced Wyandotte were represented by mature fowls as good in proportion as the pullets they would stand second best in rank in economy of production.

As far as this record goes it shows that for high production, weight of eggs produced, as well as for economy in production, pullets far outstrip hens.

Young vigorous stock is the best stock to keep for profit.

Valuation of Food Materials.

Prices at which calculations have been made for this bulletin:

Corn,55 cents per bushel, or 1 cent per pound.

Corn meal, 55 cents per bushel, or 1.1 cents per pound.

Crimson clover hay, 75 cents per hundred weight, or .75 cents per pound.

Green bone, 100 cents per hundred weight, or 10 cents per pound.

Oats before May, 1.4 cents per pound.

Oats after April, 1.6 cents per pound.

Wheat bran, .9 cents per pound.

Wheat middlings, 1.00 cents per pound.

Wheat screenings, .80 cents per pound.

Values of Eggs.

For January and June prices were approximately 15 cents per dozen. For February, March, April and May 12 cents per dozen. These prices were used in the calculations on market values.

For calculations on weight 13½ cents per dozen at a standard weight of 17.5 ounces has been used.

III. RATIONS FOR HENS AND METHODS OF FEEDING.

During the previous year our methods of feeding stock were changed somewhat and a system of supplying food in proportion to weight of fowls was begun. Under the watchful eye of Mr. F. E. Hege this worked very well. All birds were given a fairly well balanced ration and received this in proportion to weight.

When the birds were fairly using the new rations some of the larger breeds would be reduced somewhat from the full amount indicated by weight, if habits or gains in weight indicated the need, others of smaller, more active breeds would be increased in proportion as they showed the need of more food, or could use it.

This system enables the section to keep posted as to the needs of the birds, and the weights of the fowls taken often, tells a positive story of the condition of the birds not attainable by any other means. We aim to keep the birds of each breed well fed on a balanced ration, and to supply each with as much as required, or as each can consume without becoming overfat, hoping thereby to secure the best return in eggs.

After trying various rations last year and feeding a few different proportions twice and three times per day we have retained nearly the old proportions for morning and evening feeds. We have made our ration to combine several kinds of feeds and feed it with variations, so the fowls will have little or no cause to become tired of a monotonous lack of variety in the food offered them.

At the same time we can confidently count on this ration to continue for some time, and not be under the necessity of expending our force on calculations when such time may be needed elsewhere.

The rations fed during the first half of 1899 are made up as follows: 4 parts of wheat bran, 2 parts of wheat middlings and one part of corn meal are shoveled together and form the morning food. This is weighed out for each yard every morning and its proportion of crimson clover hay cut fine and steamed is added, then the whole is moistened up, using hot water in cold weather, and the cut fresh bone is then mixed into the mass.

The morning feed amounts to one-third of the day's ration of meal plus the clover and cut bone. The bones are in demand by the city's poor at times, and we are, therefore, often unable to secure enough of this material to feed all around. Notes of omissions are regularly made.

The afternoon feed was for a time scattered out on the ground where birds must scramble and hunt for it. Later we have scattered straw in and under houses and the grain is sown into the straw and hens must scratch the straw to find the afternoon feed. The fat, lazy hen goes to bed hungry on this system, and should soon become a worker and layer of eggs. This evening feed consists of corn, oats and wheat screenings. The proportions fed are six of oats and the same of screenings for two of corn, all by weight. In order to maintain proportions and make a variety in the bill of fare we feed as follows:

Supposing we start with wheat screenings on the evening of the first day and follow with oats on the second, etc. Wheat screenings, 1; oats, 2; wheat screenings, 3; corn, 4; oats, 5; wheat screenings, 6; oats, 7; then, with corn cracked, a feed is made up of these three in a mixture of three each of oats and wheat screenings to one of cracked corn, and the same weight of the mixture is fed as when feeding on other days. After ten days we return to the first day's ration and go over the same variations again. This time we may need to increase to some, and decrease to others. This is done in percentage, so the birds get the rations exact every day, except omissions of bones, which, with the hay, have been added since the ration was calculated.

The following tables show composition of morning and evening feeds separately, and the whole day's ration, including clover and bone, and the amount of a day's ration for an average White Wyandotte hen is given at the end, showing the chemical composition and feeding ratio of this ration. We do not know the percentage which hens are capable of digesting, as we do of other domestic animals, hence are obliged to base all calculations on the composition of foods, and watch effects from this standpoint. We cannot go as far as with animals of known digestive power, but we must suppose our birds are able to extract as much or more from a given amount of food as any other of our domestic friends.

Table 1 shows the composition and nutritive ratio of the ration as fed with variations.

A. Morning feed is one-third of daily ration as calculated, plus bone and clover hay after they were added to the ration.

B. This is the complete daily ration which is fed on the 1st, 3rd and 6th days of each period.

C. This is the daily ration for the 2nd, 5th and 7th days of each period.

D. This ration is fed but once in each period on the 4th day.

E. This ration completes the ten day period, being fed on the 8th, 9th and 10th.

After the bone and clover hay were added the hay became a constant in the ration and the bone a variable, depending on the market. Each ration is given by composition and ratio with and without hay and bone, and with hay and without bone, so the variations made are all calculated, though no one has been fed for a given period unchanged because of the frequent necessity of omitting bone, but all yards have received the same on the same days and in quantities to be practically *ad libitum* feeding—except that the aim has been to put the evening feed where some exertion had to be made to find the food in *ad libitum* quantity.

There are imperfections connected with feeding which we are not yet prepared to correct, and they may not be made perfect. It is hoped to do more ourselves and to receive suggestions from friends as to treatment for the English sparrow, and in some measure to overcome the tendency which we have found of some hens becoming overfat while others in the same yard remain in normal or even thin condition.

TABLE 1.—RATIONS FOR BREEDING PENS OF POULTRY YARDS.

	Amount to be Used.	Total Dry Matter.	Ash.	Protein (N x 6.25).	Crude Fiber.	N—Free Extract.	Fat, (Ether Extract).	Ratio 1:—
A.—Morning Feed for all Rations in this Series:								
Wheat Bran	400	350.28	22.40	61.48	37.28	213.76	15.40	
Wheat Middlings	200	175.98	6.60	31.20	9.20	120.80	8.00	
Corn Meal	100	84.39	1.45	9.12	1.99	67.92	3.93	
		610.65	30.45	101.80	48.47	402.48	27.33	5.1
B.—First Ration without Hay or Bone:								
Morning Mixture as above	700	610.65	30.45	101.80	48.47	402.48	27.33	
Wheat Screenings	1400	1237.60	40.60	175.00	68.60	911.40	42.00	
		1848.25	71.05	276.90	117.07	1313.88	69.33	5.79
C.—Second Ration without Hay or Bone:								
Mixture as above	700	610.65	30.45	101.80	48.47	402.48	27.33	
Oats	1400	1246.00	42.00	165.20	133.00	835.80	70.00	
		1856.65	72.45	267.00	181.47	1238.28	97.33	6.23
D.—Third Ration without Bone or Hay:								
Morning Mixture	700	610.65	30.45	101.80	48.47	402.48	27.33	
Corn	1400	1247.40	21.00	147.00	29.40	974.40	75.60	
		1858.05	51.45	248.80	77.87	1376.88	102.93	6.8
E.—Fourth Ration without Bone or Hay:								
Morning Mixture	700	610.65	30.45	101.80	48.47	402.48	27.33	
Wheat Screenings	600	530.40	17.40	75.00	29.40	390.60	18.	
Oats	600	534.00	18.00	70.80	57.00	358.20	30.	
Corn	200	178.20	3.00	21.00	42.00	139.20	10.80	
	2100	1853.25	68.85	268.60	176.87	1290.48	86.13	6.26

TABLE 1.—RATIONS FOR BREEDING PENS OR POULTRY YARDS.—CONTINUED.

	Amount to be Used.	Total Dry Matter.	Ash.	Protein N x 6.25).	Crude Fiber.	N—Free Extract.	Fat, (Ether Extract).	Ratio 1:—
F.—First Ration B	2100	1848.25	71.05	276.90	117.07	1313.88	69.33	
Crimson Clover Hay	75	66.86	5.80	11.40	19.24	29.18	1.38	
And Cut Bone	300	200.01	69.39	62.61	....	5.61	62.40	
	2475	2105.12	146.24	350.91	136.31	1348.67	133.11	5.18
G.—Second Ration C 2100, plus Crimson Clover Hay 75 and Cut Bone 300	2475	2123.52	147.64	341.01	200.71	1273.07	161.11	5.5
H.—Third Ration, D 2100. Crimson Clover Hay Hay 75 and Cut Bone 300		2124.92	127.64	322.81	97.11	1411.67	166.71	5.96
I.—Ration E, plus Hay and Bone	2475	2120.12	144.04	342.61	196.11	1325.27	149.91	5.53
J.—Ration F without Bone	2175	1905.11	76.85	288.30	136.31	1343.06	70.71	5.7
K.—Ration G without Bone	2175	1923.51	78.25	278.40	200.71	1267.46	98.71	6.16
L.—Ration H without Bone	2175	1924.91	58.25	260.20	97.11	1406.06	104.31	6.78
M.—Ration I without Bone	2175	1920.11	74.65	180.00	195.40	1319.66	87.51	6.19

IV. WEIGHT OF EGGS; THEY SHOULD SELL BY WEIGHT.

It is a point of some interest to know how heavy the eggs are from each breed of hens, also the difference in weight between the eggs of pullets and hens within each breed.

People are generally interested to know which breed lays the most eggs, but comparatively few people know or think of the fact that some breed may yield more food value in weight contained in fewer eggs, than another breed puts into a considerable larger number.

The number of eggs is only a part of what we should know of the egg production, therefore, in order to be able to judge of the relative merit of breeds, the weight, as well as the number of eggs, should be known. Then, if the amount of food consumed is known, the data is at hand to determine which of the breeds have returned the most for food consumed, and which one has therefore been the most profitable food producer.

In order to collect some data on this point, the relative weight of eggs, all the eggs from each yard of fowls under comparison have been weighed since January 1st, 1899. The following summary has been drawn out of these weights for the first six months. Further weighings will change these results some, but the more eggs weighed the less will the figures change:

TABLE SHOWING WEIGHTS.

Breed of Hens.	Pullets.				Hens.			
	Number of Eggs.	Average Weight Grams	Weight per dozen. Grams.	Weight per dozen. Ounces.	Number of Eggs.	Average Weight Grams.	Weight per dozen. Grams.	Weight per dozen. Ounces.
Barred Plymouth Rock	506	57.26	687.1	24.2	402	62.17	746.1	26.3
Late Hatched Plymouth Rock	-----	-------	-----	------	554	55.5	666.	23.5
White Plymouth Rock	478	55.74	668.9	23.6	-----	------	------	------
White Wyandotte	·689	55.76	669.1	23.6	232	55.40	664.8	23.5
Silver Laced Wyandotte	613	53.9	625.8	22.1	-----	------	------	------
Single Comb Brown Leghorn	623	49.59	495.1	17.5	535	52.82	633.8	21.7
Black Minorca	354	62.6	751.3	26.5	-----	------	------	------
Black Langshan	827	56.98	683.8	24.1	463	62.52	750.2	26.5
Buff Cochin	83	56.96	683.5	24.1	518	55.97	671.6	23.7
Light Brahma	412	55.25	663.0	23.4	118	66.23	794.8	28.0
Pekin Ducks—old and young	448	83.2	998.4	35.6	-----	------	------	------

The heaviest eggs are from the ducks. These weigh nearly $2\frac{1}{4}$ pounds per dozen. The average weights of the ducks is but (4.1 lbs.) four and one-tenth pounds.

The Light Brahma hens lay the largest hens' eggs, and these are $1\frac{3}{4}$ pounds per dozen. The lightest eggs are from Leghorn pullets, a little under ($1\frac{1}{8}$ lbs.) one and one-eighth pounds per dozen. Therefore, at the same price per dozen, if the Leghorn eggs are worth the price $13\frac{1}{2}$ cents or 12 cents per pound, the eggs of other breeds, as indicated by the above weights, should be worth, and the producer will furnish, and the purchaser receive, the following values:

	Cents.	Percentage Value Above Market.
Single Comb Brown Leghorn Pullets' eggs	13½	......
Single Comb Brown Leghorn (Hens)	16.3	20.7
Silver Laced Wyandotte (Pullets)	16.6	23.0
Light Brahma (Pullets)	17.54	30.0
Late Hatched Barred Plymouth Rock (Hens)	17.6	30.4
White Wyandotte (Hens)	17.6	30.4
White Wyandotte (Pullets)	17.7	30.4
White Plymouth Rock (Pullets)	17.7	31.1
Buff Cochin (Hens)	17.8	31.8
Black Langshan (Pullets)	17.8	31.8
Barred Plymouth Rock (Pullets)	18.2	34.8
Barred Plymouth Rock (Hens)	19.7	46.0
Buff Cochin and Black Langshan (Pullets)	19.9	47.2
Black Minorca (Pullets)	19.9	47.2
Black Langshans (Hens)	20.44	51.4
Light Brahma (Hens)	21.6	60.0
Pekin Duck (from old and young ducks)	26.7	97.8

The price fixed is not very far wrong, though it may be a little above the average, yet it is low, for this summer. We suppose the smallest eggs to be worth the market price.* This gives a fair comparison according to size of eggs. On what other article of food will people be content to pay the same price for what may vary over fifty per cent. in value? Or what producer of merchantable produce of any other kind will consent to supply all the way up to fifty-five per cent. more than market value and not think to add to the standard price for additional value?

It is notable that Pekin Duck eggs weigh about double the eggs taken as standard, while the weight of the birds is as 4.1 to 2.7.

The above expresses in order the value of eggs by weight, and the

*On careful comparison of prices with those for a long series of years (Alvord, Proc. A.A.A.S., Vol. XXXIV,) this price for weight is about 1 cent per dozen higher. It is 91 cents on 88 8-9 dozen. Based on the next larger sized eggs the price would have been 1 1-6 cents per dozen too low.

relation is shown in percentage above a given constant—the 17.5 ounces per dozen of the Single Comb Brown Leghorn pullet eggs.

The position of the Light Brahma pullets is a surprise.

The White Wyandotte hens deserve to be lower in the list than they are, because one of their number, now gone, was found to be laying a very small egg, for some time these were not separated and lowered the average.

V. FEEDING FLAVOR INTO EGGS.

It is perhaps an open question with some people whether the flavor of articles of food ever reappears in the eggs produced by hens.

The facts will not be denied for milk after a cow has been regaled on a fresh pasture containing wild onions. Neither will it, if the cow is fed turnips, or cabbage, within a few hours before milking! The flesh is probably also tainted, and we have heard reports of fried chicken flavored with onion from the recent feeding of the birds.

In March, 1899, an experiment was begun to find if a small proportion of chopped onion salad with the poultry food would flavor the eggs sufficiently to be noticeable, and if so, how long a time would be required to make the flavor noticeable; and, third, how long can the flavor be detected after the onions are left out of food.

On the 16th instant wild onion tops and bulbs were pulled on a grassy plat, and one-half ounce for each hen in a yard of twelve birds of different breeds was mixed into the morning feed. This was kept up regularly until the flavor was satisfactorily determined and the onions dropped out. The first four days of April a double amount of onion was fed, one ounce per bird, and April 5th no onion was fed and none afterwards.

In the family of the Agriculturist a number of trials down to March 31st failed to convince anyone of onion flavor in eggs from the yard fed onions.

On March 31st the flavor of onions was distinctly recognized by five persons. The Agriculturist and his wife and eldest daughter; Mr. A. A. Prince, post-graduate student, and A. E. Ames, short-course student. One member, Mrs. Goodrich, could detect no flavor of onion in egg dated March 31st.

On April 5th tried eggs laid April 3rd, and no one could bear the eggs because of the strong flavor. Those who did not know and recognize the flavor say "they did not like the eggs."

F. E. Emery tried eggs laid April 11, 13, 14th and March 23, the last a dark-shelled egg. Test on April 15th.

The dark-shelled egg only contained onion flavor.

No white-shelled eggs have been found flavored with onion, and the presumption is that the hens which have given these eggs have omitted the onion from their diet. Dark-shelled egg laid April 11th was found well-flavored on April 16th.

A number of neighbors were asked to test some of the eggs produced by the "reserve yard" which received the onions, and so far as positive reports were received no one found onion flavor in white eggs of any date. The following notes were received relative to these trials:

PROF. EMERY:

The three eggs you sent were tested as follows:

Boiled 7 minutes and tested while hot: Egg marked 4-3 (April 5th), yolk yellow; taste not of best, thought could detect onion.

Egg marked 4-4, same as above.

Egg marked 4-13, yolk light-colored and flavor fine.

Yours truly,

J. R. CHAMBERLAIN.

PROF. F. E. EMERY.

Dear Sir: The four eggs sent us to note difference in flavor were boiled 8 minutes and eaten hot. The following are our conclusions:

Date of Egg.	Shell Color.	Yolk Color.	Flavor.
1—3, 24.	White	Light	Nothing unusual.
2—4, 5.	Dark	Dark	Tastes like wild onion.
3—4, 6.	Medium Dark.	Dark	Tastes like wild onion more strongly than No. 2.
4—4, 14.	Dark	Dark	Nothing unusual.

MRS. F. E. HEGE.
F. E. HEGE.

1st. It is probable that no eggs after a week's abstinence are ill-flavored with onion.

2nd. It seems probable that the hens, Brown Leghorn and Black Minorca, which laid the white eggs, refused to eat the onion.

3rd. Flavors can be fed into eggs.

4th. Therefore it appears that to insure fine-flavored eggs it is necessary to restrict runs enough so no considerable amount of the food can be of such a character as to yield ill-flavored eggs.

TABLE 2.—SHOWING COST OF FEED, AND THE PRODUCTION OF EGGS FOR EACH BREED OF FOWLS FOR JANUARY, 1899.

Number of Yard.	Name of Breed.	No. of Birds.	Wheat Bran.	Wheat Middlings.	Corn Meal.	Wheat Screeni'gs.	Oats.	Corn.	Crimson Clover Hay.	Green Bone.	Total Cost.	Av'ge cost per Bird per month.	Total. No. of Eggs.	Total. Value of Eggs.	Average Per Hen. Eggs	Average Per Hen. Value
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Cents.		$		Cents.
1	Single Comb Brown Leghorn (hens and pullets)	35+1	9.72	4.86	2.43	34.00	34.00	11.94	4.50	17.90	$1.43	4.00	101	1.26	3	4.
2	White Plymouth Rock (pullets)	8+1	14.02	7.00	3.50	21.00	21.00	6.99	2.63	10.51	.88	10.00	20	.25	2.5	3.13
4	Black Langshan (hens)	8+1	14.09	7.50	3.75	22.53	22.53	7.42	2.69	11.23	.96	10.50	64	.80	8	10.
5	Single Comb Brown Leghorn (hens)	8+1	9.61	4.80	2.49	14.42	14.42	4.82	1.84	7.23	.68	7.50	17	.21	2	2.6
6	Black Langshan (pullets)	8+1	13.54	6.77	3.38	20.13	20.45	6.81	2.53	10.37	.96	10.50	76	.95	10	12.50
7	Barred Plymouth Rock (hens)	8+1	18.70	9.35	4.67	27.99	27.99	9.50	3.50	14.02	1.27	14.00	52	.65	6	8.
8	Barred Plymouth Rock (pullets)	7+1	14.53	7.26	3.63	21.76	21.76	7.39	2.72	10.89	1.03	13.00	50	.63	7	9.
9	Single Comb Brown Leghorn (pullets)	8+1	7.70	3.85	1.92	11.77	11.77	3.90	1.45	5.81	.55	6.00	28	.35	3.5	4.4
10	White Wyandotte (hens)	7+1	10.74	5.37	2.68	16.16	16.16	5.76	2.00	8.06	.77	9.5	18	.22	2.6	3.
10½	White Wyandotte (pull'ts)*	$6+1\frac{6}{11}$	3.90	1.95	0.98	5.34	5.34	1.59	0.65	2.63	.23	.035	21	.26	3.5	4.4
15	Buff Cochin (hens)	8+1	15.78	7.89	3.94	23.60	23.60	10.20	2.46	9.57	1.03	.11½	0	.00	0.0	0.0
11	Light Brahma (hens)	5+1	8.95	4.47	2.23	13.52	13.52	4.26	1.76	7.27	.65	.11	1	.01	+	+
11½	Light Brahma (pullets)	4+1	9.28	4.64	2.32	13.51	13.51	4.61	1.61	6.91	.65	.13	27	.33	7	8.
17	Barred Plymouth Rock (hens) late hatched	8+1	14.19	7.09	3.54	21.27	21.27	7.10	2.66	10.76	1.01	.11¼	52	.63	6	8.

*Yard 10½ was in its quarters only 11 days in January.

E. & O. E.

TABLE 3.—SHOWING COST OF FEED AND THE PRODUCTION OF EGGS FOR EACH BREED OF FOWLS FOR FEBRUARY, 1899.

Number of Yard.	Name of Breed.	No. of Birds.	Wheat Bran.	Wheat Middlings.	Corn Meal.	Wheat Screeni'gs.	Oats.	Corn.	Crimson Clover Hay.	Green Bone.	Total Cost.	Ave'ge Cost per Bird in cts. per Mo.	Total. No. of Eggs.	Total. Value of Eggs.	Average per Hen. No. of Eggs.	Average per Hen. Value of Eggs.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.				Cents.		Cents.
1	Barred Plymouth Rock a) S. C. B. Leghorn	33+2	37.55	18.78	9.39	56.32	56.32	18.77	7.25	20.06	$.230	6.57	227	227.	7	7.
2	White Plymouth Rock (pullets)	8+1	13.39	6.69	3.35	20.20	20.20	6.73	2.73	6.81	.803	8.92	71	71.	9	9.
4	Black Langshan (hens)	8+1	14.64	7.32	3.66	22.18	22.18	7.39	2.77	7.90	.904	10.04	66	66.	8+	8.
5	Single Comb Brown Leghorn (hens)	8+1	8.45	4.23	2.11	12.69	12.69	4.23	1.60	4.54	.518	5.76	44	44.	5.5	5.5
6	Black Langshan (pullets)	8+1	12.81	6.41	3.20	19.21	19.21	6.40	2.31	6.66	.777	8.63	97	97.	12	12.
7	Barred Plymouth Rock (hens)	7¼+1	15.48	7.74	3.87	23.20	23.20	7.80	2.90	8.25	.945	11.50	50	50.	6.91	6.91
8	Barred Plymouth Rock (pullets)	7+1	11.22	5.61	3.81	16.84	16.84	5.61	2.10	6.03	.677	8.46	67	67.	9.6	9.6
9	Single Comb Brown Leghorn (pullets)	8+1	6.70	3.34	1.68	9.20	9.20	3.07	1.25	3.60	.395	4.40	29	29.	3.62	3.62
10	White Wyandotte (hens) b	6.5+1	9.25	4.63	2.31	14.13	13.73	4.76	1.65	4.90	.561	7.48	27	27.	4.15	4.15
10½	White Wyandotte (pullets	c6+1	8.97	4.49	2.24	13.13	13.68	4.55	1.66	4.86	.547	7.84	63	63.	10.5	10.5
11	Light Brahma (hens)	5+1	11.23	5.61	2.81	16.84	16.84	5.61	2.10	6.00	.677	11.28	2	2.	+	+
11½	Light Brahma (pullets)	4+1	8.93	4.47	2.24	13.41	13.41	4.47	1.68	4.77	.54	10.8	50	50.	12.5	12.5
12	Pekin Ducks (old and young)	23+11	36.81	18.41	9.20	55.42	55.42	18.02	7.00	20.10	2.209	6.50	00	00.	0.0	0.0
13	Buff Cochin (pullets) d	4.6+1	7.77	3.89	1.95	11.67	11.67	3.89	1.44	4.06	.458	8.18	21	21.	4.56	4.56
14	Silver Laced Wyandotte (pullets)	8+1	9.76	4.88	2.44	14.62	15.54	4.57	1.84	5.00	.602	6.7	37	37.	4.6	4.6
16½	Black Minocra (pullets)	4+1	5.91	2.95	1.48	9.04	9.04	3.01	1.13	3.22	.337	6.74	10	10.	2.5	2.5
17	Barred Plymouth Rock (hens)	8+1	13.11	6.56	3.28	19.76	19.76	6.59	2.44	6.55	.797	8.88	53	53.	6.6	6.6

E. & O. E. (*a*) Two Barred Plymouth Rock cockerels. (*b*) 7 hens 14 days; 6 hens 14 days; cockerel 12 days. (*c*) Only 6 pullets; cockerel in this yard 16 days. (*d*) Five pullets 18 days; four pullets 10 days; one having been set.

TABLE 4.—SHOWING COST OF FEED AND THE EGG PRODUCTION OF EACH BREED OF FOWLS FOR MARCH, 1899.

Number of Yard.	Name of Breed.	Number of Birds.	Wheat Bran.	Wheat Middlings.	Corn Meal.	Wheat Screen'gs.	Oats.	Corn.	Crims'n Clover Hay.	Green Bone.	Total Cost.	Ave'ge cost per Bird in cts. per Mo	Total. No. of Eggs.	Total. Val. of Eggs.	Average Per Hen. No. of Eggs.	Average Per Hen. Value of Eggs.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.				$		Cents.
1	S. C. Brown Leghorn (hens and pullets)	29+2	18.12	9.06	4.53	49.07	48.41	16.14	3.15	10.89	$1.6635	5.37	529	5.29	18+	18.0
2	White Plymouth Rock (pullets)	8 +1	14.20	7.10	3.55	21.51	21.23	6.99	2.56	9.22	.8782	9.76	125	1.25	16.	16.00
2½	White Wyandotte (pullets)	b7 +1	11.62	5.81	2.90	17.52	17.37	5.77	2.25	8.43	.728	9.10	119	1.19	20.	20.0
4	Black Langshan (hens)	8 +1	16.63	8.32	4.16	24.95	24.95	8.32	3.11	10.86	1.032	11.47	158	1.58	20.	20.0
5	S. C. Brown Leghorn (hens)	8 +1	9.33	4.66	2.33	14.03	14.03	4.68	1.71	6.10	.579	6.43	126	1.26	16.	16.0
6	Black Langshan (pullets)	a8 +1	12.25	6.13	3.06	18.35	17.82	6.22	2.31	8.22	.758	9.47	158	1.58	23	23.6
7	Barred Plymouth Rock (hens)	6½+1	15.61	7.80	3.90	24.23	24.57	8.28	3.30	11.58	1.008	13.44	117	1.17	18.	18.
8	Barred Plymouth Rock (pullets)	8 +1	11.62	5.81	2.90	17.43	17.43	5.81	2.19	7.59	.725	8.05	129	1.29	16	16.1
9	S. C. Brown Leghorn (pullets)	8 +1	7.40	3.70	1.85	7.56	7.56	2.52	1.38	4.78	.368	4.09	121	1.21	15.	15.1
10	White Wyandotte (hens)	6 +3/7	5.03	2.52	1.26	14.62	15.14	4.88	1.81	6.38	.535	4.11	61	.61	10.	10.16
10½	White Wyandotte (pullets)	6 +4/7	8.48	4.24	2.12	13.01	12.49	4.15	1.68	6.18	.538	4.13	107	1.07	18.	18.
11	Light Brahma (hens)	5 +1	9.93	4.96	2.48	19.92	19.92	6.64	1.84	6.76	.746	12.43	57	.57	11.4	11.40
11½	Light Brahma (pullets)	c4 +1	10.19	5.09	2.55	15.29	15.29	5.10	1.91	6.67	.637	12.74	100	1.00	25.	25.00
12	Pekin Ducks (old and young)	d22 +10	51.00	25.50	12.75	76.50	76.50	25.50	9.50	33.10	3.17	9.91	108	1.08	5	5.0
13	Buff Cochin (pullets)	5 +1	6.93	3.47	1.73	10.60	10.28	3.34	1.18	4.34	.424	7.07	46	.46	9	9.2
14	Silver Laced Wyandotte (pullets)	8 +1	13.60	6.79	3.39	20.39	20.39	6.79	2.53	8.87	.832	9.33	165	1.65	21	20.6
15	Buff Cochin (hens)	7 +1	14.48	7.24	3.62	21.72	21.72	7.21	2.74	9.81	.879	11.00	128	1.28	18	18.0
16	Black Minorcas (pullets)	5 +1	7.77	3.89	1.94	11.66	11.66	3.89	5.81	11.83	.57	9.50	49	.49	10.	9.8
17	Barred Plymouth Rock (hens)	8 +1	15.60	7.79	3.90	23.41	23.41	7.80	2.92	10.91	.97	10.80	178	1.78	22	22.25
16½	Black Minorca (pullets)	5 +1	6.09	3.05	1.52	9.14	9.14	3.03	1.17	4.58	.385	6.42	36	.36	7	7.2
18	Buff Cochin	5 +1	10.23	5.11	2.56	15.32	15.32	5.15	1.88	6.71	.633	10.55	69	.69	14	13.8
19	Black Langshan	12 +1	17.36	8.69	4.35	26.07	26.07	8.69	3.28	10.53	1.067	8.41	187	1.87	15+	15.6

(*a*) Hens were sitting during the month, so this number was reduced to an average of 7 plus 1. (*b*) One hen with stolen nest; only 6 should be counted for eggs. These were late pullets. (*c*) One hen broody 10 days, but this not counted in average. (*d*) The average was 22. Began the month with 23 and ended with 21. E. & O. E.

TABLE 5.—SHOWING COST OF FEED AND THE PRODUCTION OF EGGS OF EACH BREED OF FOWLS FOR APRIL, 1899.

Number of Yard.	Name of Breed.	No. of Birds.	Wheat Bran.	Wheat Middlings.	Corn Meal.	Wheat Screenings.	Oats.	Corn.	Crimson Clover Hay.	Green Bone.	Total Cost.	Average Cost per Bird.	Total. No. of Eggs	Total. Value of Eggs.	Average Per Hen. No. of Eggs.	Average Per Hen. Value of Eggs.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.				Cents.		Cents.
2	White Plymouth Rock	7+1	11.33	5.67	2.83	16.98	16.98	5.71	2.26	6.94	$0.70	8.75	94	94.0	13+	13.43
2½	White Wyandotte	6+1	10.77	5.39	2.69	16.12	16.20	5.37	1.90	6.23	0.66	9.43	96	96.0	16	16.
4	Black Langshan	6+1	12.12	6.07	3.03	18.24	18.24	6.08	2.27	6.82	0.75	10.70	88	88.0	*15	14.67
5	Leghorn	8+1	9.04	4.52	2.26	13.55	13.55	4.51	1.72	5.22	0.56	6.22	127	127.0	*16	15.88
6	Black Langshan	6+1	6.64	3.33	1.66	9.85	10.28	3.22	1.25	3.93	0.41	5.86	66	66.0	11	11.0
7	Barred Plymouth Rock	6+1	11.72	5.86	2.93	17.70	17.40	5.90	2.29	7.19	0.72	10.29	68	68.0	12	12.0
8	Barred Plymouth Rock	6+1	9.71	4.86	2.43	14.85	14.70	4.90	1.85	5.63	0.60	8.57	100	100.0	*17	16.67
9	S. C. Brown Leghorn	8+1	7.44	3.72	1.86	11.17	11.17	3.72	1.39	4.26	0.45	5.00	135	135.0	*17	16.88
10	White Wyandotte	7+½	9.48	4.75	2.37	14.07	14.07	4.61	1.61	5.02	0.57	7.60	64	64.0	9+	9.14
10½	White Wyandotte	5+½	3.00	1.45	0.75	8.05	7.83	2.21	0.86	2.63	0.27	4.91	58	58.0	*12	11.60
11	Light Brahma	2½+1	4.41	2.21	1.10	8.05	7.83	2.21	2.63	0.86	0.298	8.52	35	35.0	14	14.00
11½	Light Brahma	3+1	8.69	4.35	2.17	13.97	13.86	4.62	1.68	5.22	0.618	15.45	75	75.0	25	25.00
12	Pekin Ducks	18+11	47.32	23.65	11.82	70.74	70.77	21.20	8.74	27.06	2.897	9.99	151	151.0	8+	8.4
13	Buff Cochin	4+1	2.56	1.29	0.64	3.83	3.83	1.32	0.45	1.20	0.157	3.14	16	16.0	4	4.0
14	Silver Laced Wyandotte	8+1	11.60	5.80	2.90	17.48	17.33	5.81	2.18	6.70	0.72	8.00	143	143.0	18	18.0
15	Buff Cochin	5+1	11.10	5.56	2.78	16.12	16.12	5.42	1.98	6.10	0.67	11.16	57	57.	11.4	11.4
16	Black Minorca	5+1	7.20	3.70	1.80	12.70	12.70	3.53	1.34	6.36	0.51	8.5	69	69.	14	13.8
17	Barred Plymouth Rock	6+1	10.56	5.28	2.64	16.17	16.19	5.36	1.47	5.88	0.65	9.28	123	123.00	20+	20.5

* Nearly.
E. & O. E.

TABLE 6.—SHOWING COST OF FEED AND PRODUCTION OF EGGS FOR EACH BREED OF FOWLS FOR MAY, 1899.

Number of Yard.	Name of Breed.	No. of Birds.	Bran.	Wheat Middlings.	Corn Meal.	Wheat Screenings.	Oats.	Corn.	Crimson Clover Hay.	Green Bone.	Total Cost.	Average Cost.	Number of Eggs.	Average Per Hen. No. of Eggs.	Average Per Hen. Value of Eggs.
			Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Cents.			
1	Light Brahma	3.6+1	6.60	3.30	1.65	9.53	9.66	3.31	1.06	3.11	$0.41	8.9	63	17.5	17.50
2	White Plymouth Rocks	7.7+1	12.36	6.18	3.09	19.35	17.86	5.97	2.30	6.26	.80	9.2	117	15+	15.20
4	Black Langshan	4.5+1	10.08	5.04	2.52	16.31	15.24	5.20	2.12	5.11	.66	12.00	65	14.4	14.44
5	Single Comb Brown Leghorn	8+1	9.12	4.56	2.28	14.23	13.18	4.39	1.71	4.65	.58	6.40	130	16.25	16.25
6	Black Langshan	5+1	10.04	5.02	2.51	15.38	14.48	4.83	1.86	5.00	.63	10.50	96	19.2	19.20
7	Barred Plymouth Rock	7.7+1	14.16	7.08	3.54	22.10	21.10	6.86	2.66	7.17	1.01	11.6	48	6.2	6.23
8	Barred Plymouth Rock	5+1	9.84	4.92	2.46	15.39	14.42	5.02	1.83	4.97	.63	10.5	67	13.4	13.40
9	Single Comb Brown Leghorn	8+1	6.32	3.16	1.58	10.84	9.97	3.32	1.32	3.66	.43	4.4	172	21.5	21.50
10	White Wyandotte	4+$\frac{3}{5}$	8.00	4.00	2.00	12.55	11.55	3.99	1.52	3.98	.51	11.0	23	5.75	5.75
10½	White Wyandotte	6.6+$\frac{2}{5}$	8.72	4.36	2.18	14.15	13.06	4.44	1.58	4.47	.57	8.1	79	*12	11.97
11	Light Brahma	5.5+1	3.60	1.80	.90	12.00	11.42	3.91	.84	2.35	.41	6.3	19	3.45	3.45
11½	Light Brahma	1.3+1	6.60	3.30	1.65	10.33	9.65	3.21	1.23	3.43	.42	18.26	26	20.0	20.00
12	Pekin Ducks	18+11	36.96	18.48	9.24	57.83	53.65	17.88	6.93	18.79	2.36	8.10	125	6.9	6.94
14	Silver Laced Wyandotte	7.2+1	10.28	5.14	2.57	15.99	14.81	5.06	1.73	5.22	.65	7.90	128	*18	17.78
15	Buff Cochin	6.9+1	15.36	7.68	3.84	24.27	22.10	7.64	2.86	7.84	.72	9.10	95	*14	13.77
16	Black Minorca	6+1	9.36	4.68	2.34	12.48	12.48	4.54	1.75	4.77	.54	7.70	71	10	10.14
17	Barred Plymouth Rock	4.5+1	10.00	5.00	2.50	14.64	13.55	4.59	1.81	5.07	.61	11.10	62	*14	13.78

* Nearly.
E. & O. E.

TABLE 7.—SHOWING COST OF FEED AND PBODUCTION OF EGGS FOR EACH BREED OF FOWLS FOR JUNE, 1899.

Number of Yard.	Name of Breed.	No. of Birds.	Wheat Bran.	Wheat Middlings.	Corn Meal.	Wheat Screenings.	Oats.	Corn.	Crimson Clover Hay.	Green Bone.	Total Cost.	Average Cost per Bird.	No. of Eggs.	Average Per Hen.	
														No. of Eggs.	Value of Eggs.
			Lbs	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Cents.*	*Cents.*			*Cents.*
1	Light Brahma (pullets)	4.4 +1	5.68	2.84	1.42	9.10	8.80	3.08	1.17	3.55	38.38	7.11	24	5.5	6.88
2	White Plymouth Rock (pullets)	6.7 +1	10.74	5.37	2.68	14.90	14.90	5.56	2.83	6.07	67.50	8.77	57	8.	10.02
4	Black Langshan (hens)	3.2 +1	7.29	3.64	1.82	11.30	10.82	3.75	1.21	3.21	46.42	11.05	22	7.	8.75
5	S. C. Brown Leghorn (hens)	8 +1	8.96	4.48	2.24	13.88	13.88	4.60	1.65	5.28	59.43	6.60	91	11+	14.20
6	Black Langshan	6.3 +1	11.82	5.46	2.73	13.03	13.07	4.42	1.80	5.50	61.70	8.45	78	12.4	15.50
7	Barred Plymouth Rock	6.7 +1	14.44	7.22	3.61	20.11	19.94	6.63	2.60	7.83	88.58	11.50	67	10.	12.50
8	Barred Plymouth Rock	5.4 +1	12.16	6.08	3.04	15.35	15.18	5.00	1.84	5.42	68.73	10.74	93	17.2	21.52
9	S. C. Brown Leghorn	8 +1	6.08	3.04	1.52	10.35	10.35	3.45	1.36	2.75	42.56	5.32	138	17.25	21.56
10½	White Wyandotte	6.4 +1	9.84	4.92	2.46	14.81	14.81	5.00	1.82	5.68	64.07	8.66	91	14.22	17.78
10	White Wyandotte	4.3 +1	7.00	3.50	1.75	12.40	12.40	4.13	1.56	4.41	51.20	9.66	39	9.07	11.34
11	Light Brahma	3.6 +1	6.88	3.44	1.72	13.42	13.17	4.31	1.52	4.84	53.59	11.65	4	1.11	1.39
11½	Light Brahma	2.07+1	6.60	3.30	1.65	11.06	10.71	3.57	1.22	3.63	45.15	14.71	26	12.56	15.70
12	Pekin Ducks	18+11	36.68	18.34	9.17	55.03	55.03	18.12	6.85	21.13	205.90	7.10	65	3.6	4.5
14	Silver Laced Wyandotte	6.5 +1	9.12	4.56	4.28	13.02	13.04	4.27	1.22	4.71	58.65	7.82	125	19.23	24.04
15	Buff Cochin	6.7 +1	16.48	8.24	4.12	20.67	20.55	6.58	1.87	8.53	93.51	12.14	81	12.09	15.11
16	Black Minorca	6 +1	9.16	4.58	2.29	13.76	13.76	4.61	1.71	5.29	59.55	8.51	58	9.67	12.08
17	Barred Plymouth Rock (hens)	5.5 +1	9.71	4.86	2.43	16.03	15.66	5.00	2.01	4.27	63.93	9.84	86	15.64	19.55

E. & O. E.

TABLE 8.—DETAILED RESULTS OF BREED-TESTS, DRAWN FROM TABLES 2 TO 7. AMERICAN CLASS.

	BARRED PLYMOUTH ROCK.									WHITE WYANDOTTE.					
	LATE HATCHED HENS. (2 Years.)			PULLETS.			HENS. (2 Years.)			PULLETS.			HENS.		
	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.
	Cents.		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*
January	3.50	3.50	4.40	13.00	7.0	9.00	14.00	6.00	8.00	3.50	3.50	4.40	9.50	2.60	3.00
February	8.88	6.60	6.60	8.46	9.60	9.60	11.50	6.91	6.91	7.84	10.50	10.50	7.48	4.15	4.15
March	10.80	22.00	22.25	8.05	16.00	16.10	13.44	18.00	18.00	4.13	18.00	18.00	4.11	10.00	10.16
April	9.28	20.+	20.50	8.57	16.67	16.67	10.29	12.00	12.00	4.91	12.00	11.60	7.60	9.00	9.14
May	11.10	13.8	13.78	10.50	13.40	13.40	11.60	6.20	6.23	8.10	12.00	11.97	11.00	5.75	5.75
June	9.84	15.64	19.55	10.74	17.20	21.52	11.50	10.00	12.50	8.66	14.20	17.78	9.66	9.07	11.34
	53.40	81.54	87.08	59.32	79.87	86.29	72.33	59.11	63.64	37.14	70.2	74.25	49.35	40.57	43.54
Averages per month	8.9	13.59	14.51	9.887	13.31	14.38	12.055	9.852	10.607	6.19	11.7	12.375	8.225	6.76	7.257

TABLE 8.—CONTINUED. AMERICAN AND MEDITERRANEAN CLASSES.

	Silver Laced Wyand'te Pullets.			White Plymouth Rock Pullets.			Black Minorca Pullets.			Brown Leghorn Pullets.			Brown Leghorn Hens.		
	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.
	Cents.		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*
January	…	…	…	10.00	2.50	3.13	…	…	…	6.00	3.50	4.40	7.50	2.00	2.50
February	6.70	4.60	4.60	8.92	9.00	9.00	6.74	2.50	2.50	4.40	3.62	3.62	5.76	5.50	5.50
March	9.33	20.60	20.60	9.76	16.00	16.00	6.42	7.20	7.20	4.09	15.10	15.10	6.43	16.00	16.0
April	8.00	18.00	18.00	8.75	13.43	13.43	8.50	13.80	13.8	5.00	16.88	16.88	6.22	15.88	15.88
May	7.90	17.78	17.78	9.20	15.20	15.20	7.70	10.14	10.14	4.40	21.50	21.50	6.40	16.25	16.25
June	7.82	19.23	24.04	8.77	8.00	10.20	8.51	9.67	12.08	5.32	17.25	21.56	6.60	11.37	14.20
	39.75	80.21	85.02	55.40	64.13	66.96	37.87	43.31	45.72	29.21	77.43	82.64	38.91	67.00	70.33
Averages per month	7.678	16.04	17.004	9.23	10.69	11.13	7.574	8.662	9.144	4.87	12.905	13.773	6.485	11.17	11.72

TABLE 8.—CONTINUED. ASIATIC CLASS.

	Buff Cochins.						Black Langshan.					
	Pullets.			Hens.			Pullets.			Hens.		
	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.
	Cents.		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*
January	....	....	....	11.50	....	....	10.50	10.00	12.50	10.50	8.00	10.00
February	8.18	4.56	4.56	9.10	3.00	3.00	8.63	12.00	12.00	10.40	8.00	8.00
March	7.07	9.20	9.20	11.00	18.00	18.00	9.47	23.60	23.60	11.47	20.00	20.00
April	*3.14	4.00	4.00	11.16	11.40	11.40	5.86	11.00	11.00	10.70	14.67	14.67
May	....	....	....	9.10	13.77	13.77	10.50	19.20	19.20	12.00	14.40	14.44
June	....	....	....	12.14	12.09	15.11	8.45	12.40	15.50	11.05	7.00	8.75
	18.39	17.76	17.76	64.00	58.26	61.28	53.41	88.20	93.80	66.12	72.07	75.86
Averages per month	7.07	6.83	6.83	10.67	9.71	10.21	8.90	14.70	15.63	11.02	12.01	12.643

* Yard closed after 18 days in April.

TABLE 8.—CONTINUED.

	Light Brahmas.						Pekin Ducks.		
	Pullets.			Hens.					
	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No. of Eggs per Hen.	Value of Eggs per Hen.	Cost of Food per Hen.	No of Eggs per Hen.	Value of Eggs per Hen.
	Cents.		*Cents.*	*Cents.*		*Cents.*	*Cents.*		*Cents.*
January	13.00	7.00	8.75	11.00	0.20	0.25	......	......	......
February	10.80	12.50	12.50	11.28	0.40	0.40	6.50	......	......
March	12.74	25.00	25.00	12.43	11.40	11.40	9.91	5.0	5.00
April	15.45	25.00	25.00	8.52	14.00	14.00	9.99	8.40	8.40
May	18.26	20.00	20.00	6.30	3.45	3.45	8.10	6.94	6.94
June	14.71	12.56	15.70	11.65	1.11	1.39	7.10	3.6	4.50
	84.96	102.06	106.95	61.18	30.56	30.89	41.60	23.94	24.84
Averages per month	14.16	17.01	17.825	10.197	5.093	5.15	......	......	......

E. & O. E.

RECENT BULLETINS.

The following are some of the recent Bulletins of the Experiment Station:

No. 111. The Fertilizer Control During 1894, pp. 26.
No. 112. Trucking in the South, pp. 70.
No. 113. The Testing of Milk, cuts 4, pp. 32.
No. 114. Tests of Dairy Implements and Practices, cuts 4, pp. 32.
No. 115. Miscellaneous Agricultural Topics, pp. 20.
No. 116. Milk Records and Tests, pp. 16.
No. 117. Tuberculosis and Its Prevention, pp. 20.
No. 118. Cotton Seed Hulls for Beef Production, pp. 4.
No. 119. Volumetric Estimation of Phosphoric Acid, pp. 21.
No. 120. Cultivation of the Peach Tree, 42 cuts, pp. 31.
No. 121. Hillside Terraces or Ditches, 8 cuts, pp. 5.
No. 122. Types of Tobacco and Their Analyses (Technical), pp. 35.
No. 123. Miscellaneous Agricultural Topics, pp. 10.
No. 125. Forage Grasses and Hay Making, 44 cuts, 49 pages.
No. 128. Pests of Grain Crops, pp. 12.
No. 129. Horticultural Experiments at Southern Pines, 1895, pp. 46.
No. 130. Poultry Keeping for Profit, 39 cuts, pp. 53.
No. 132. The Home Vegetable Garden and Its Pests, 8 cuts, pp. 54.
No. 133 Some New Forage Fibre and Other Useful Plants, pp. 2.
No. 136. Fertilizer Analyses of the Fertilizer Control, pp. 34.
No. 137. A Warning in Regard to Compost Peddlers, pp. 8.
No. 138 San Jose Scale in North Carolina, 1 cut, pp. 14.
No. 139. Home-Mixed Fertilizers and Composts, pp. 16.
No. 140. Volumetric Estimation of Phosphoric Acid (Technical), pp. 8.
No. 141. A New Tobacco Pest, 2 cuts, pp. 8.
No. 142. Comfortable Low Cost Barns, 12 cuts, pp. 20.
No. 143. Feeding Experiments, Milk Records, etc., pp. 36.
No. 144. Ornithology of North Carolina, pp. 36.
No. 145. Crimson Clover, pp. 20.
No. 146. Miscellaneous Farm Bulletin, pp. 16.
No. 147. A Study of Lettuces, pp. 8.
No. 148. Digestion Experiments, pp. 32.
No. 149 The Apple in North Carolina, pp. 22.
No. 150. Medicinal Plants of North Carolina, pp. 84.
No. 151. The Fertilizer Control for 1897, pp. 12.
No. 152. Poultry Notes, pp. 24.
No. 153. Vinegar Adulteration, pp. 8.
No. 154. The Adulteration of Coffee and Tea, pp. 16.
No. 155. Baking Powders on Sale in North Carolina, pp. 8.
No. 156. The Adulteration of Flour, pp. 12.
No. 157. Mineraline, pp. 8.
No. 158. The Fertilizer Control for 1898, pp. 16.
No. 159. Horticultural Experiments at Southern Pines, 1896, pp. 92.
No. 160. Digestion Experiments, pp. 20.
No. 161. Drinking Water, pp. 20.
No. 162. Farming in North Carolina, pp. 34.
No. 163. Rational Stock Feeding, pp. 28.
No. 164. The Flora of North Carolina, pp. 80.
No. 165. Preservatives in Canned Foods, pp. 8.
No. 166. Butter, pp 12.
No. 167. Poultry Experiments, pp. 32.
No. 168. Experiments with Field and Forage Crops, pp. 16.
No. 169. Feeding Experiments and Milk Records.

Any of the above will be sent cheerfully upon application by Postal Card to the Director of the N. C. Agricultural Experiment Station, Raleigh, N. C.

BULLETIN NO. 168 *JUNE 30, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, M.A., ACTING DIRECTOR

Experiments with Field and Forage Crops

I. SEEDING FOR PASTURE;
II. PERMANENT IMPROVEMENTS;
III. TIMOTHY SEEDING;
IV. IMPROVEMENT OF PEANUTS;
V. COTTON VARIETIES, 1898;
VI. SACHALINE OR SAGHALIN;
VII. PRICKLY COMFREY;
VIII. VARIETY TEST OF WHEAT, 1898-'9.

F. E. EMERY

RALEIGH, N. C

Publications will be sent to any address in North Carolina upon application.

* Delayed in preparation.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E. EMERY, M.S., Agriculturist.*
W. F. MASSEY, C.E., Horticulturist.*
COOPER CURTICE, D.V.S., M.D., (1) Veterinarian.*
G. S. FRAPS, Ph.D., Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist
J. M. JOHNSON, M.S., Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B.E., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M., State Chemist.
C. B. WILLIAMS, M.S., Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY, Assistant Chemist.
W. G. HAYWOOD, B.LITT., Assistant Chemist.
H. E. KING. Chief Clerk.
MISS M. S. BIRDSONG, Stenographer.

The Director's office is in the main building of the College. Telephone No 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

*Member of Station Council
(1) On leave of absence.

EXPERIMENTS WITH FIELD AND FORAGE CROPS.

By F. E. Emery, M.S , Agriculturist.

I. SEEDING FOR PASTURE.

In the fall of 1890 very soon after assuming charge of the Experiment Farm two acres were seeded for pasture. The land was thin and very poor.

This was the treatment it received and the result:

20 pounds, $1\frac{3}{7}$ bushels, Tall Oat Grass Seed.
10 pounds, $\frac{5}{7}$ bushel, Orchard Grass Seed.
2 pounds, $\frac{1}{7}$ bushel, Red Top Grass Seed.
4 pounds, $\frac{2}{7}$ bushel, Kentucky Blue Grass Seed.
15 pounds, $\frac{1}{4}$ bushel, Red Clover Seed.

Manure was spread and cut in with disk harrow in fitting for seed over the poorer part of the field. Afterward a light top dressing of manure was given. The seed was sown October 12th, 1890. In June, 1891, most of this lot was cut over for hay, and when a little later aftermath had started well it was pastured. This was used for nearly three years, and was heavily stocked for the area and yielded very well as a grazing lot.

In 1893 this pasture was plowed and grew corn, and after the corn was a part of four acres seeded again for pasture. The seeding this time was done in midsummer, the seed being sown August 14th, 1893.

The seeding this time was as follows for four acres:

56 pounds Orchard Grass Seed (*Doctylis glomerata*).
30 pounds Red Top (*Agrostis vulgaris*).
28 pounds Kentucky Blue (*Poa pratensis*).
20 pounds Red Clover Seed (*Trifolium pratense.*)
10 pounds White Clover Seeds (*Trifolium repens*).
1 pound Alsike Clover Seed (*Trifolium hybridum*).

This was at rate of two bushels and one-half pound of best grass seeds per acre, with 5 pounds red clover, $2\frac{1}{2}$ pounds white clover, and $\frac{1}{4}$ pound of alsike clover seed per acre.

This grass did well during the fall and winter, and few people have seen a more luxuriant pasture than the Station cows and sheep luxuriated in during the summer of 1894.

But it must be said that in the preparation for this pasture the whole field received $6\frac{1}{4}$ tons per acre of stable manure and 5 tons in all of spent manure, over half of which had been washed into the soil elsewhere. This was put on during the winter of 1893, and the

field was then plowed and grew a crop of corn. It was in this field of corn, which yielded 10.85 tons per acre of well cured corn for the silo, that the accompanying reproduction of a photograph was taken, showing corn and Johnson grass *(sorghum halapense)*, which grew up with the corn. Cutivators purposely left it. The corn was cut July 26 to August 10, 1893, and the ground immediately plowed with single plows, except the stiffest half acre, and the seed put in as given above.

After the Page woven wire fence, which has been so satisfactory an investment, was put in and two acres more added to the pasture, a mixture of a large number of odds and ends in grass seeds was sown on the new part.

With this grass seed, much of which was old and dead, was sown a few clover seeds, as follows:

Common Red Clover Seed. 1⅝ pounds per acre.
Perennial Red Clover, 2 pounds per acre.
White Clover, 3 pounds per acre.

This part of the pasture for a long time when white clover was in bloom seem as though there need have been no other plants on the field for a luxuriant growth.

This seeding has given most excellent results until it was over-pastured too long, 1897-1898, when it became necessary to plow it again for renewal and to close out animal parasites, which have attacked sheep strongly, and which breed in the moist ground.

This year (1899) there is a luxuriant growth of corn on the whole six acres.

Any one advocating sowing down pasture or lawn grasses without white clover has not mastered the reason for things. This clover is very desirable for its after effect on the grasses, affording them really a considerable amount of food in decaying stems and roots.

The dairy field at A. & M. College was seeded for pasture September 30, 1898.

This field produced a very heavy crop of corn, 17½ tons per acre for the silo, and was immediately prepared for pasturing cows as a night pasture and other use. Sowed 500 pounds chemical manure, which was harrowed in previous to sowing the seed. This consisted of:

The grass seeds sown were for four acres.

	Total.
Orchard Grass (*Doctylis glomerata*). 3 bushels	42 pounds.
Kentucky Blue (*Poa pratensis*). 2 bushels	28 pounds
Tall Meadow Oat (*Avena salva*)	42 pounds.
Meadow Fox Tail (*Aloperensus pratensis*). 3 bushels	21 pounds.
Creeping Bent { (*Poa compressa*). 2 bushels	28 pounds.
Creeping Bent { (*Agrostis slolorrifera*)	14 pounds.
White Clover (*Trifolium repens*)	3 pounds
Red Clover (*Trifolium pratense*)	16 pounds.

Messrs. Johnson and Skinner have ordered the grazing, and no particularly accurate account of the number of animals fed can be given, but it has been taken down nearly accurate by Mr. Johnson, as follows:

April and May 35 cattle 10 days, equivalent to 350 for one day.
May, June and July 9 cattle 90 days, equivalent to 810 for one day.
August to 23d 3 cattle 23 days, equivalent to 69 for one day.
May, June, July and August 3 horses 35 days, equivalent to 105 horses one day.
May, June, July and August 2 mules 35 days, equivalent to 70 mules one day.

Messrs. Johnson and Skinner estimated the horses and mules as equivalent to 8 cattle, and summed up the amount of grazing to have been *not* less than 1,529 days for one animal between turning out in April and August 23rd.

The grass is still thrifty, though rather short to go into hot weather, but the clover is in active growth, and since the recent rains if not pastured much now until the growth covers the crowns, and some shade is thus afforded from the hot sun, the amount of grazing which can be taken before April next year may nearly equal what has already been secured. Great care should be exercised to keep the land from being grazed too close. Better a light growth wasted in early fall and at mid-winter than to have the bare crowns of the plants exposed to the September sun or to chance freezes in winter.

II. PERMANENT IMPROVEMENTS.

During the period October, 1890, to August, 1899, during which Experiment Farm has been under the charge of the writer there has been a very marked increase in the fertility of the farm. This has been due to the following:

1st. Keeping some kind of crop on the land nearly all the time.

2d. Changing the crops from so-called gross-feeders to recuperative crops so-called.

3rd. To the free use of stable manure from well-fed stock. This is one of the chief causes of improvement, coupled with constant attention to growing crops to give the necessary work as soon as needed, and thus save the water in the soil to the plants.

This last is of so much importance that a *press service bulletin* was devoted to it early in this period, which bulletin was widely copied and disseminated by agricultural and other papers.

The office building was made larger by the addition of a needed second story.

The barn shed was fitted up expressly for cattle feeding experiments, and is as convenient and well-suited a place for such experiments as can be found. See Bulletin No. 143, p. 188.

The barn water supply, consisting of a 13,000 gallon tank set into the ground on a slope at northwest corner of barn, two to four feet, has been one of these, though not really a "permanent" supply.

since the tank will eventually need to be renewed. However, for over eight years this tank has contained rainwater enough for all uses at the barn, where one horse, a pair of mules or work horses, and as high as fifteen head of cattle have been supplied the year round from the rainfall on the barn. So long as this climate continues to average 50 inches of precipitation it seems necessary only to proportion the area of collecting surface, and volume of stored water to the needs for work in hand to be sure of a bountiful supply.

Farmers would do well to note this source of really good water for many purposes in places where good pure water is otherwise not easy to obtain.

The Page wire fence, shutting in six acres for pasture, or other use, is one of the permanent improvements, as is the change from the old board fence on the north to Page wire fence.

This change needs to be continued round on the west and south sides.

The improvement in the land has been the most notable feature.

When it came under this management all experiment work had been abandoned, except a little variety testing, and this by the Horticultural Division was soon abandoned.

When the farm was projected here it was the opinion of the Commissioner of Agriculture at the time that the land was "fit for nothing but ballast."

These years of cattle raising and cropping has not only raised the condemnation for barrenness, but within the past year the same horticulturist, who abandoned the place as unfit for experiments, has concluded it is "the only fit place" for his work. He has also been extolling the system used to bring up this land which was so severely condemned, and which we honestly believe is well worth the earnest interest of thousands of North Carolina farmers.

See reports of addresses by Agriculturist at Farmers' Institutes and those of the Horticulturist, August, 1899, for confirmation.

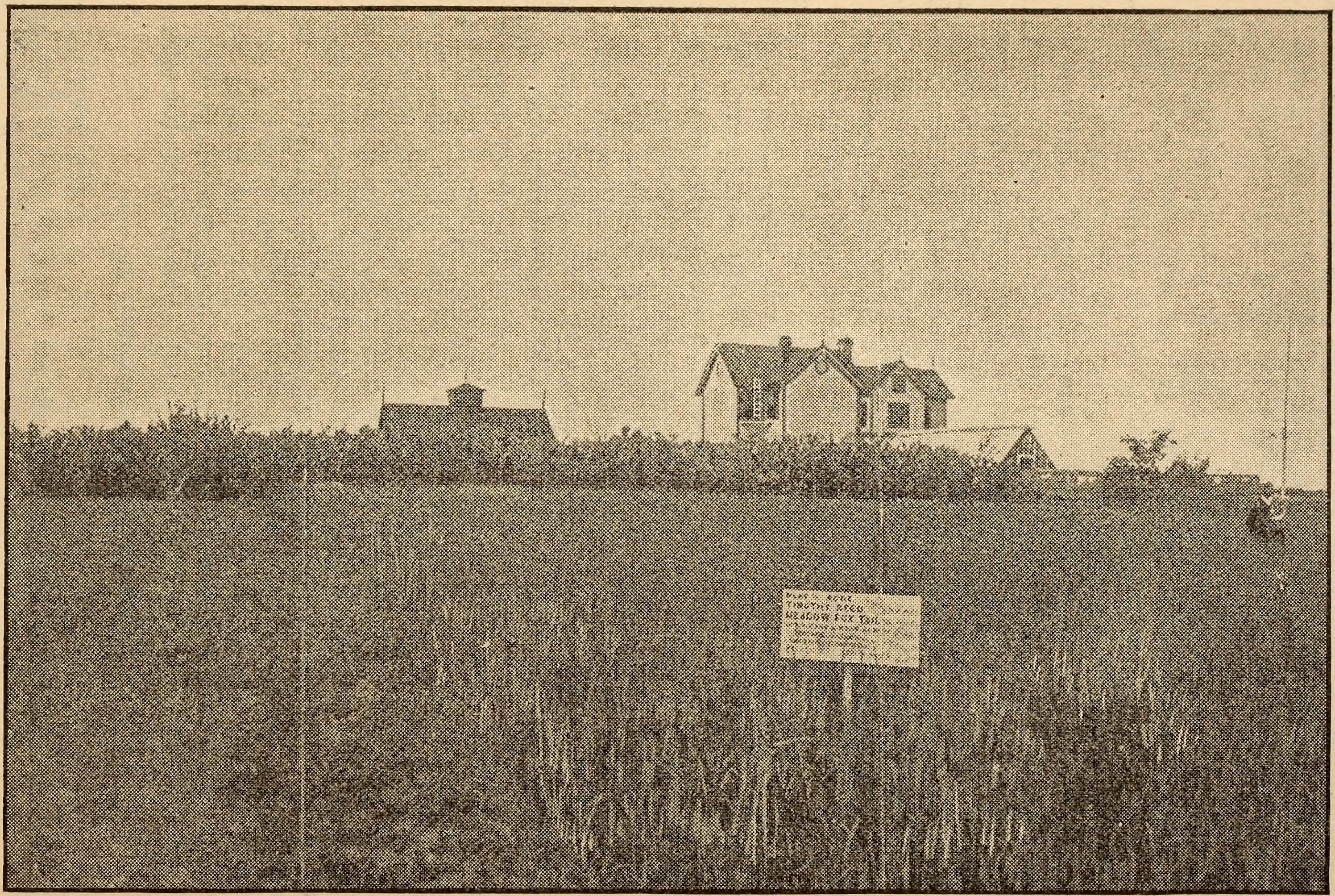
The steam power and machines of greater capacity have been added.

Repairs to pipes and porches to dwelling, as well as attention to its roof, are now needed.

Some tile drains have been laid for experimental observation, and a temperature and soil moisture apparatus purchased to use in this connection.

III. TIMOTHY SEEDING.

The accompanying cut shows a plat of Timothy at the Experiment Farm. This grass grows from seed here as well as in the North. It is cheaper to seed with Timothy than with most other grasses, eight to twelve quarts of seed being required per acre. A fall seeding on rich ground sown early, or on later sowing and followed by a mild winter can be depended on for hay in May or June.



TIMOTHY—N. C. Agricultural Experiment Station.

But, it is not sure at all of withstanding the summer's heat. The bulbs at the base of the stems are injured by dry sun heat, and the grass dies.

Timothy will do for a single cutting, and grown in this way will afford good hay.

IV. IMPROVEMENT OF PEANUTS.

This experiment was begun several years ago, but moles destroyed so much of the seed there was only scattering hills harvested.

In 1898 a plat was planted from seed selected as follows: A lot of Virginia peanuts were assorted into one celled, two celled, three celled and four celled pods. The meats shelled out of these several lots were planted separately, as the beginning of a trial, to find out if possible what changes can be wrought by such selection in peanuts under like and favorable conditions of growth. Only good meats were used, except in some cases, where rows were planted with meats from "partly filled" two, three or four celled pods, as distinguished from full pods.

The seed was planted April 29, 1898. All rows had vegetated by May 12th, and bloom was found on every row by June 12th.

After planting an application of lime was made on the plat, sowing it both ways, so it would be evenly distributed over the whole plat. No other manure was applied. The plat used was S. W. corner of old wheat plats and S. end of original comfrey plat.

The table following gives some statistics of this crop. The first weights were made as the nuts were picked off and sorted in the field.

The original seed contained many "pops," and was, therefore, rather unsuited to yield a fair proportion of the different meated pods, so no counts and weights were made beyond securing good seed. It is seen by the table that about five per cent. of this first crop from selected seed was single-meated pods, thirty per cent. double-meated pods and over fifty per cent. three-meated pods. There were about fourteen per cent. four- meated pods. These proportions were singularly alike from each classification in this first crop. The greatest tendency is to produce pods containing three meats and next with two meats under favorable conditions.

This crop yield was of 121 bushels per acre, since the hills were 2 by 3 feet apart, and one-third of a pound was the average yield per hill.

This serves as a basis on which to determine whether selection for several years turns the force of inheritance toward the same number of meats per pod as the seed-pods contained or toward more or less.

Yield.—The whole plat was 42x60 feet, comprising 2,520 square feet. The yield of 114.85 pounds of peanuts when assorted in December was, therefore, at the rate of 99.26 bushels of 20 pounds per acre.

RESULTS ON THE PEANUT PLATS.

Seed Planted from Kinds of Pods.	No. of Hills.	Harvest Weights. Vines.	Harvest Weights. Pods.	Weights as Sorted Dec. 5, 1898. 1-Celled.	Weights as Sorted Dec. 5, 1898. 2-Celled.	Weights as Sorted Dec. 5, 1898. 3-Celled.	Weights as Sorted Dec. 5, 1898. 4-Celled.	Total Weight.	Weight per Hill.	Per Cent of Crop in 1-Celled	Per Cent of Crop in 2-Celled.	Per Cent of Crop in 3-Celled.	Per Cent of Crop in 4-Celled.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*				
Partly filled 4-celled pods	23	15½	12.60	.45	1.90	2.90	.95	6.20	.27				
Full 4-celled pods	16	11½	6.70	.30	1.85	3.70	1.00	6.85	.428	5.32	28.72	51.28	14.68
Partly filled 4-celled pods	25	15½	10.80	.50	3.00	5.45	1.50	10.45	.418				
Partly filled 3-celled pods	25	15	9.20	.45	2.70	4.95	1.35	9.45	.378	4.87	30.19	51.79	13.15
Full 3-celled pods	52	35	21.50	1.05	6.60	11.00	2.70	27.35	.391				
Half filled 2-celled pods	16	11	5.60	.35	1.80	2.85	.75	5.75	.36	5.77	30.72	50.31	13.20
Full 2-celled pods	50	33	18.625	1.05	5.65	9.35	2.45	18.50	.37				
1-celled pods	80	46	......	1.25	7.35	13.60	3.60	25.80	.3225	5.24	28.51	52.20	14.05
1-celled pods	54	24	10.20	.65	3.00	5.35	1.50	10.50	.194				
	341	......	......	6.05	33.85	59.15	15.80	114.85	.337	5.27	29.47	51.50	13.76

V. COTTON: COMPARISON OF TWO VARIETIES, 1898.

Two varieties of cotton were planted on carefully measured plats of one-tenth acre each. The plats were treated exactly alike in preparation and manure.

One, the north plat, had a tree on each corner next to the road, which took up quite one square rod of the plat, and on which little cotton could grow. King's cotton was planted on this north plat. Anson Queen, from T. C. Robinson, of Anson county, was planted on the adjacent plat, both in rows equally distant and extending east and west.

The cotton was planted April 26, 1898.

The cultivation given these plats was the same given other crops. The Iron Age cultivator was used as often as needed after each rain or shower to keep the soil from becoming encrusted and hard.

The first picking of cotton was made on September 7th.

On account of the small area and our desire to secure the whole crop the cotton was picked over about once a week until it had all opened.

The King cotton was about two-thirds out in September, while the greater part of Anson Queen was picked in October; the latest part of the crop being on the southwest corner, where the weed was rankest.

The yield from the King cotton was at ginning 186.625 pounds.

The yield from Anson Queen was at ginning 198.5 pounds.

The gin gave the following result:

	Pounds of Seed.	Pounds of Lint.	Per Cent of Seed.	Per Cent of Lint.
King's No. 1	118.5	67.5	63.7	36.3
Anson Queen	131.25	66.75	66.9	33.1

VI. SACHALINE, OR SAGHALIN.

(*Polyganum Saghalinense.*)

Two roots of this highly recommended forage plant were set a yard apart in the spring of 1895. One cutting was made of the earliest shoots; the plants were cultivated in July, and the second growth left to fall after frost. First cutting 4 feet tall.

One plant has thriven and the other did not. The east plant was taken up in 1898, and as many sets made as could be, and these were put out in a row, but were rather slow to start, and were plowed up. The stronger hill continued to thrive, and now 1899, after one cutting this season, is luxuriant enough to cover about four square yards, and is in full bloom in August.

The cuttings have been calculated at one square yard, and are shown below. When two cuttings have been made there has been a smaller growth before the close of the season, which has been left standing over winter.

The plant is when vigorous inclined to spread out from the center by subterranean branches.

	EAST HILL.			WEST HILL.		
	No. Stems Cut.	Pounds Cut.	Rate per Acre.	No. Stems Cut.	Pounds Cut.	Rate per Acre.
			Lbs.			*Lbs.*
May 9, 1896	?	$\frac{7}{8}$	4[illegible]4.	26	$4\frac{5}{16}$	25900.
June 17, 1896				?	$3\frac{1}{2}$	16940.
June 2, 1897*	9	$\frac{7}{16}$	2117	29	$3\frac{13}{16}$	18450.
May 11, 1898†		$\frac{7}{8}$	424.	40	$6\frac{3}{8}$	30855.
June 15, 1898	12	$1\frac{3}{4}$	8470.	36	$7\frac{1}{8}$	34485.
May 10, 1899				?	$9\frac{3}{4}$	47190.

This crop might be grown for forage on small areas where it could be cut over several times, and would probably pay for cultivation by intensive milk producers. Other than intensive growers should not try it.

VII. PRICKLY COMFREY.

(*Symphytum Asperrimum.*)

This plant has been in use for forage in this country a comparatively short time.

Peter Henderson says of it:**

"*S. asperrimum* was introduced into this country as a forage plant in 1875, but has proved to be entirely valueless for that purpose. Propagation by seeds or division."

Dr. Henry Foster, Clifton Springs, N. Y., began using this plant in 1880 or 1881, and after five years of successful cultivation became enthusiastic in its praise. The New York State Experiment Station procured a stock of plants for one-twentieth acre and cultivated the plant, increasing the area to one-fifth, and later to one and one-fourth acres, feeding the forage to cows and pigs.

A trial to make it into silage resulted in failure. The plant is illy suited to such use, while it is well suited to cultivation on small

* Severely cut back by frost early in season.
† Spring growth severely injured by frost in the early part of April.
** Henderson's Handbook of Plants and General Horticulture.—p. 442.

areas of very rich land. Dr. Foster had about five acres under cultivation in comfrey in 1886 and cut it over as many as five times, manuring and cultivating the ground immediately after each cutting.

The Assistant Chemist of the New York Station, Prof. E. F. Ladd, made several analyses of the forage. As no analyses of this plant have been made here we append copy of those made in New York:*

Samples From—	Water.	Ash.	Albuminoids.	Crude Fiber.	N. Free Extract.	Fat (Ether-Extract.)
Dr. Foster, fresh substance	88.24	1.64	1.88	2.66	5.27	0.31
Station, fresh substance	88.70	3.16	3.69	3.19	10.42	0.84
Crop of 1884, fresh subst'ce	86.14	2.56	3.25	2.00	5.68	0.37
Dr. Foster, dry substance		13.93	16.00	22.66	44.76	2.65
Station, dry substance		14.83	17.31	14.98	48.91	3.97
Crop of 1884, dry substance		18.45	23.44	14.43	41.02	2.66

These analyses show some variations and indicate that about one-eighth of the fresh plants is dry matter.

Samples of comfrey were sent out to other Stations from New York. A plat was planted here at Experiment Farm soon after the reorganization as an U. S. Hatch Station, and comfrey has been continuously grown here since that year, 1889. The plat has been moved three times, and each time it has seemed to grow as well or better for the change as when it remains for a long time in one place. Indeed, the frequent cultivation after manuring with stable manure and the penetration of its deep fleshy roots seem to leave the land in much better condition than it is when the comfrey is put on it.

The *Boraginaceae*, to which this plant belongs, is subject to attack of fungus, one or more of which have been present on our plats, as indicated by certain plants dying down, while the most of the area was in active growth. In some seasons this, or a lack of water, has prevented cutting more than two or three times. When planted in shallow soil, with impervious clay subsoil, the third growth (1898) has withered down and shrivelled to the ground after large enough to begin cutting, evidently from a lack of water alone.

Cuttings have been made from two to five times in a season here. We feel sure that if irrigation could be applied, or this plant be set on moister land that double our yields could be realized from it.

As an example of what may be expected under high manuring the yield of 1892, the last crop cut from the original plat is shown below.

*Sixth Annual Report N. Y. Agricultural Experiment Station.—p. 422.

The grapery had been built and a trench outside of the wall of the house filled with earth and manure, the same as the inside, two and one-half to three feet deep. There were five rows, and the yield from the row nearest the heavily manured trench was about six feet distant, but it showed so much gain from some source, and the manure trench was the only available source, that the rows and hills were cut and weighed separately to show the effect of heavy manuring on prickly comfrey.

It was in this year that fungus attacked the plat, and it was moved to give place to bulb growing by the Horticultural Division.

The plat was uncut until June 7th, when it had put out bloom, and was nearly ready to mature seed. The yields by rows from the number of hills named were as follows, the eleven heaviest yielding hills in the west row were nearest and opposite the trench mentioned above:

Number of Row, Counting from East toward Trench.	Number of Hills per Row Cut.	Yield per Row.	Yield per Acre.
		Lbs.	*Lbs.*
East Row	50	77.3125	14960.
Second Row	51	67.625	12820.
Third Row	50	70.50	13640.
Fourth Row	53	93.9375	17160.
Fifth Row	49	183.9375	36340.
Fifth Row	38	121.5	30940.
Fifth Row	11	62.7	54940.

The comfrey had rather a hard time of it with fungus during 1892, and the last of September was removed as above noted, and roots from the strongest, or undiseased hills, were used for stock in the new situation on the third terrace. The cultivation, hoeing and resetting is about all the record for comfrey in 1893.

Division of "hills" had to be resorted to in 1894 to keep the stand good, but the disease had been overcome, and three cuttings were afforded this year. Below are yields as cut and calculated per acre:

	Yield Per Acre.
1894.	
First cutting—June 6 to 10—960 pounds	6,720
Second cutting—July 13 to 18—781 pounds	5,467
Third cutting—September 7-15—1,375 pounds	9,625
Total	21,812
1895.	
First cutting—April 21-30—606 pounds	4,242
Second cutting—May 1-16—3,454 pounds	24.178
Total	28,420
1896.	
First cutting—May 1-10—835 pounds	5,845
May 21-June 11—1,300 pounds	9,100
July 22-August 2—480 pounds	3,360
Total	18,305

1897.	Yield Per Acre.
First cutting—May 17—546 pounds+?	5,460
Second cutting—June 21-25—780 pounds	7,800
Total	13,260

Dry weather caused the third growth to shrivel after it was nearly large enough to cut and the plants remained dormant the rest of the year.

1898.	Yield Per Acre.
First cutting—April 9 to 24—548 pounds	5,480
Second cutting—May 4 to 14—499 pounds	4,990
Third cutting—June 2 to 12—407 pounds	4,070
Fourth cutting—July 30—191 pounds	1,910
To'al	16,450
1899.	
Cutting May 2-11—1,185* pounds	11,850
Cutting † July 22, August 3—2,102 pounds	13,478
Total	35,328

There was a promising start made for third growth, which will be large if cultivation is given before grass takes the lead.

VIII. WHEAT VARIETIES, 1899.

In the fall of 1898 sixteen samples of wheat from farmers in North Carolina were planted. This test of varieties was made on a plat which had grown a variety of legumes in that year, and the seed taken off where seed had ripened, and in two instances the whole crop was removed. These were a crop of peanuts and a bean vine, the seed of which was presented by Prof. Auguste deVillile from the Island of Reunion, a French province in the Indian Ocean, and which did not bloom, although a luxuriant growth of vines were secured.

The only manure used on this plat was slaked lime for the peanuts in 1898.

No manure was given the wheat. Wheat plats were laid off at right angles to rows of legumes.

Notes were made when the plats were beginning to approach maturity, as follows:

1. Everitt's High Grade.—Heads of average size; slightly bearded at top. Stems slightly inclined to bluish; medium height.
2. Fultz.—Very like No. 1. Difference very slight, if any at all. Heads lighter colored.

---

* At the first cutting the poultry yards were without green food. and a bunch was cut for each yard every day. No account was made of this, though it amounted to considerable in the aggregate.

† This was the first cutting in the new situation, where the area was .156 acre. The May cutting was from one-tenth acre.

3. Red Cross.—Heads light, golden green and larger at top than at base. Stems very blue and straw shorter than on plats 1, 2 or 4.
4. Fauntleroy.—Very golden; stems slightly inclined to bluish on top.
5. Bearded Fulcaster.—Tallest wheat on plat; leaves and stems green, the latter slightly inclined to bluish; large bearded heads; very even to where vines were removed in 1898, where straw is shorter; mixture of some beardless wheat in plat.
6. Red Russian.—Golden green heads; slightly bearded at top; stems green; slightly inclined to bluish; stature rather less than plats 5 and 8; contains a mixture of a few bearded stools.
7. Fultz Amber.—Beardless except slight tuft at top; rather golden heads; stems inclined to bluish; contains a few bearded stools; height about as No. 6.
8. Fulcaster.—Tallest wheat. (See plat 5.)
9. Davis.—Heads light golden; slightly bearded at top; taller than next, No. 10; slightly inclined to bluish; few bearded stools.
10. Kivett.—Stems green; heads golden green; slightly bearded at top; contains quite a sprinkling of bearded heads.
11. Little Red.—Heads short, small, light-colored; stems bluish; contains a few bearded heads.
12. Duplicate of No. 11, but from different source.
13. Harris Prolific.—Heads dark golden, large and long; stems green.
14. Little Red.—(See note for No. 11.)
15. Rice Wheat.—Stems green; heads golden; beardless.
16. A mixed wheat grown here at Experiment Farm in 1893, and kept in seed-room. Seed was a little rancid. The writer has noted at various times that seed which from age or some unfavorable condition has changed enough to be rancid to the taste will not grow.

This wheat failed to come up.

The following table shows the yields per acre of sheaf wheat, straw and chaff, and total grain, also the relative proportion of each as graded by the complete self-bagger, manufactured by Winston Agricultural Works, Winston, N. C.:

The highest yield was made by Fauntleroy, which for J. F. Homeward, Burlington, N. C., has this year averaged 20 bushels per acre on 90 acres.

The second best is one of the Fulcaster plats. Everitt's High Grade, Red Russian, and Fultz are the next in weight of yield. The Bearded Fulcaster stands the best chance where English sparrows are numerous, as these birds attack beardless wheat first, and do more damage to it than to the stiff bearded wheat.

The wheat was planted late, December 17, 1898.

YIELDS OF WHEAT, VARIETY TEST, 1899.—CALCULATED PER ACRE.

No of Plat.	NAME OF VARIETY.	SEED RECEIVED FROM	Weight of Wheat in Sheaf.	Straw and Chaff.	Cleaned Grain.	WHEAT GRADED INTO:		
						No. 1.	No. 2.	No. 3.
			Lbs. Per Acre.	*Lbs. Per Acre.*	*Bushels Per Acre.*			
1	Everitt's High Grade	J. F. Homeward, Burlington, N. C.	3744.1	2440.6	21.7	6.43	13.98	0.72
18	Everitt's High Grade	J. F. Homeward, Burlington, N. C.	2787.8	1858.5	15.5	3.02	11.22	0.98
2	Fultz	J. F. Homeward, Burlington, N. C.	3276.0	2008.1	21.1	7.09	12.86	0.66
19	Fultz	J. F. Homeward, Burlington, N. C.	2661.8	1724.6	15.8	1.25	11.75	2.10
3	Red Cross	J. F. Homeward, Burlington, N. C.	1886.2	1228.5	*10.96	1.77	7.81	1.18
20	Red Cross	J. F. Homeward, Burlington, N. C.	2071.1	1228.5	14.05	2.30	9.98	1.84
4	Fauntleroy	J. F. Homeward, Burlington, N. C.	3508.0	2228.6	*21.50	4.33	15.82	0.85
21	Fauntleroy	J. F. Homeward, Burlington, N. C.	4248.6	2575.1	27.89	9.32	17.46	0.79
5	Fulcaster Bearded	J. F. Homeward, Burlington, N. C.	3165.6	2016.	19.23	8.66	10.10	0.20
22	Fulcaster Bearded	J. F. Homeward, Burlington, N. C.	3720.9	2240.4	24.68	11.88	12.21	0.38
6	Red Russian	J. F. Homeward, Burlington, N. C.	3102.8	2077.1	†17.09	4.95	10.16	1.13
23	Red Russian	J. F. Homeward, Burlington, N. C.	2890.1	1578.9	21.84	4.66	15.55	1.45
7	Fultz or Amber	Dr. J. A. Wolf, Tobaccoville	3366.6	2260.1	18.43	4.07	12.53	1.58
8	Fulcaster Bearded	Dr. J. A. Wolf, Tobaccoville	3780.	2583.0	19.95	6.63	12.60	0.26
9	Davis	Dr. J. A. Wolf, Tobaccoville	2984.6	1913.6	17.85	5.05	11.35	0.92
10	Kivett	Dr. J. A. Wolf, Tobaccoville	2264.1	1366.3	14.84	3.74	9.38	0.85
11	Little Red	Dr. J. A. Wolf, Tobaccoville	2736.6	1740.4	16.60	0.98	10.76	4.40
12	Red Wheat	J. A. Long, Roxboro	2646.0	1638.0	‡16.80	3.54	11.29	1.51
13	Harris' Prolific	J. E. Harris, Hurdle's Mills	1547.4	952.9	9.91	1.71	16.99	1.58
16	Harris' Prolific	J. E. Harris, Hurdle's Mills	1759.0	1089.3	11.16	0.71	7.00	3.06
14	Little Red		2672.1	1677.4	16.54	1.44	11.81	3.08
17	Little Red	J. A. Wolf, Tobaccoville	2546.5	1653.8	14.88	0.44	8.82	5.54
15	Rice Wheat	J. E. Harris, Hurdle's Mills	2331.0	1531.7	12.99	5.38	7.09	0.26
			2856.4	1809.4	17.50			

* Damaged by birds and rats.

† Two sheaves were found with heads cut off by rats while stored in barn Calculated for by two other similar sheaves in the above table.

‡ Mr. Long says:—This wheat has been cultivated and kept up by our farmers for, I suppose, twenty years, and it has always been known as Red Wheat.

BULLETIN No. 169 *JUNE 30, 1899

THE NORTH CAROLINA

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

W. A. WITHERS, A.M., ACTING DIRECTOR

Feeding Experiments

AND

MILK RECORDS

I. Wheat Bran vs. Rice Bran in Combination with Cotton-Seed Meal and Corn Bran.
II. Wheat Bran Alone vs. Rice Bran Alone
III. Wheat Bran vs. Rice Bran in Combination with Cotton-Seed Meal.
IV. Half Wheat Middlings vs. Wheat Bran Alone.
V. Addition of Millet Hay to Ration of Corn Silage, Wheat Bran and Pea Meal.
VI. Wheat Bran and Cotton-Seed Meal vs. Rice Bran and Cotton-Seed Meal.
VII. Wheat Bran and Cotton-Seed Meal vs. Wheat Middlings and Cotton-Seed Meal.
VIII. Wheat Bran and Cotton Seed Meal vs. Wheat Bran Alone.
IX. Milk Records at the Experiment Farm.

F. E. EMERY AND J. M. JOHNSON.

RALEIGH, N. C.

Publications will be sent to any address in North Carolina upon application.

*Delayed in preparation.

THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

EXPERIMENT STATION STAFF.

ALEX. Q. HOLLADAY, LL.D., President of the College.*
W. A. WITHERS, A.M., Acting Director and Chemist.*
F. E. EMERY, M.S., Agriculturist.*
W. F. MASSEY, C.E., Horticulturist.*
COOPER CURTICE, D.V.S., M.D., (1) Veterinarian.*
G. S. FRAPS, Ph.D., Assistant Chemist.
J. A. BIZZELL, B.S., Assistant Chemist.
H. W. PRIMROSE, B.S., Assistant Chemist.
ALEX. RHODES, Assistant Horticulturist.
C. W. HYAMS, Assistant Botanist.
J. M. JOHNSON, M.S., Assistant Agriculturist.
B. S. SKINNER, Farm Superintendent.
J. M. FIX, Secretary.
C. M. HUGHES, B.S., Clerk.
MRS. L. V. DARBY, Stenographer.

FERTILIZER CONTROL DIVISION.

A. W. BLAIR, A.M., State Chemist.
C. B. WILLIAMS, M.S., Assistant Chemist.
C. D. HARRIS, B.S., Assistant Chemist.
F. G. KELLY, Assistant Chemist.
W. G. HAYWOOD, B.LITT., Assistant Chemist.
H. E. KING, Chief Clerk.
MISS M. S. BIRDSONG, Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

Samples for analysis should be sent to the State Chemist.

---

*Member of Station Council.
(1) On leave of absence.

LETTER OF TRANSMITTAL.

THE N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.
AGRICULTURAL EXPERIMENT STATION.
DIVISION OF AGRICULTURE.
RALEIGH, N. C.

SIR: I have the honor to transmit herewith data collected in feeding ensilage and various by-products to milch cows. This is intended for a bulletin to answer various queries about the relative value of several of these articles and to call attention to the subject of feeding cows and the importance of keeping a record of their yields of milk to the end that the owner may know whether a given cow is making or losing money for him.

These experiments were conducted during the fall and winter of 1897 and 1898, and have been repeated in part in the college herd.

The feeding for this work was done under the immediate supervision of Mr. Emery, and the testing of milk was done by both Mr. Emery and Mr. Johnson, mainly the latter. Later tests, however, have been all done by Mr. Johnson, and the repeated feeding trials were made under his supervision in the college barn.

There are upwards of 200,000 cows in North Carolina. If the owners of one-tenth of these cows could be interested, by means of this bulletin, to keep a record of the food consumed and the milk produced, and to compare the values of these, this effect would well repay the cost. It would doubtless lead to some changes of opinions and practices among the owners, feeders and milkers of cows in North Carolina. There has been a marked change among many farmers in feeding and care of cows, as well as in the care taken of milk, since this Station began the publication of its work in this line. This present bulletin adds to what has been printed before, and may furnish some encouragement to keepers of common cows since these are nearly all cows of common stock. The largest records in the Experiment Farm herd have been made by developed common cows with no royal breeding. They are not better than well-bred cows, but serve to show that profitable returns can be secured from common cows when they are selected with care and fed well. I am sir, etc.,

FRANK E. EMERY.

To the Acting Director.

BULLETINS ON ANIMAL INDUSTRY.

No. 80c. Digestibility of Cotton-Seed Hulls.
No. 81. Feeding Cotton-Seed Hulls and Meal for the Production of Beef
No. 87d. Digestion Experiments.
No. 93. Feeding Experiments.
No. 97. Digestion Experiments.
No. 99. Thread Worm of Pork.
No. 101. Progress of the Dairy Industry in North Carolina.
No. 102. Encouragement to the Dairy Industry.
No. 109. Feeding Trials with Animals.
No. 113. Testing of Milk.
No. 114. Tests of Dairy Implements and Practices.
No. 116. Milk Records and Tests.
No. 117. Tuberculosis and Its Prevention
No. 118. Cotton-Seed Hulls for Beef Production.
No. 126. Why Not Improve Your Poultry.
No. 130. Poultry Keeping for Profit.
No. 131. Parasites of Poultry.
No. 143. Feeding Experiments, Milk Record, Etc.
No. 148. Digestion Experiments.
No. 152. Poultry Notes.
No. 160. Digestion Experiments.
No. 163. Rational Stock Feeding.
No. 167. Poultry Experiments.

Any of the above will be sent upon application by postal card addressed to the Director of the Agricultural Experiment Station, Raleigh, N. C.

FEEDING EXPERIMENTS WITH MILCH COWS.

By F. E. Emery, M. S., Agriculturist.

Daily Yields and Tests.

The yields given in tables with rations were averaged from the four days at the end of each period on which composite samples were taken for the determination of fat.

Table IV contains total yields of milk and same of fat as calculated from total yield of milk using per cent of fat found near the last end of each period.

The three additional periods serve to show that there are limits to raising the flow of milk when it has held up to or above normal amount for a long period. The last period some corn meal was fed with peavine hay to restore some flesh to cow Spot. Cow No. 7 was not continued through the later periods.

Weights of Cows.

Where not otherwise mentioned the weights of the cows may be considered as fairly maintained. Cows were weighed daily in most of the trials, with usual daily variations, which are controlled by the accidents of amount and time of water consumed on the previous days and evacuation of bowel. Where the weight has been observed to materially increase or diminish it will be noted.

The Cows Used in Experiments.

Cow Spot. Fresh December 8th, 1896. Had attack resembling foul in foot which probably came from chemicals in the gutter. She was not dry during 1897 and freshened again March 2, 1897, consequently this cow was long past full flow when the experimental feeding was begun.

Cow No. 7. This cow was of the dairy form—doublewedge—always kept fat, and milked about the average quantity per year*. No. 7 was fresh early in August, 1897, before this experiment began in October.

Angus' No. 7. This was a grade Polled Angus heifer from cow No. 7. This heifer came in fresh November 19th 1897, with red cow calf by Honesty. Angus' No. 7 was two years old September

* For records, see Bulletin No. 143.

1st, 1897. Black, and to all appearances like a full-blood Polled Angus.

Jersey King 2nd's Daisy E. This grade or cross-bred brindled heifer from Jersey King, Farmer's Glory on one side, was from a red Shorthorn cow, Daisy E., of unknown breeding, but an excellent milker. Her breeding was strong enough to carry white markings on feet to her cow calf by the Jersey bull and through this heifer to her calf by Honesty, a Shorthorn bull, calved December 3rd 1897.

Jersey King 2nd's No. 5. This heifer gave very little milk, and as two of her half sisters have developed in that way it seems to be a family trait to develop slowly, but the dam No. 5 and one heifer having proved excellent milkers, these were kept to develop. This milk period was from a premature start in July, when it should have been in December.

Miss Native. This heifer was born February 7, 1896. Her dam cow No. 20, was a small red native, and Miss Native appeared to have been a grade devon. She came in milk December 5th, 1896.

May. Registered Shorthorn heifer, recently received from New York. Fresh with first calf in March. Bred again.

Sue. Registered Shorthorn heifer, recently received from New York. Fresh with first calf in April. Bred again.

I. WHEAT BRAN vs. RICE BRAN IN COMBINATION WITH COTTON SEED-MEAL AND CORN BRAN.

By F. E. Emery, M. S., Agriculturist.

Cows "Spot" and "No. 7," Heifer Jersey King 2nds No. 5.

The rations were corn silage *ad libitum* and a mixture of corn bran, rice bran, and cotton-seed meal in equal parts by weight, during the first and fourth periods of ten days. During the second and third periods wheat and corn brans were fed with cotton-seed meal. This is only a change of one-third of the ration, or of half the part added to the cotton-seed meal.

This combination of periods equalizes the natural diminution of flow of milk and the average yield for two periods gives the most accurate comparison of yields and of effects of the rations.

Rations in which corn silage is the only source of the bulky or coarse food, are low in organic and nutritive substances. The amount of digestible substance is greater than shown here and the ratio is wider than shown because of the increased digestibility of carbohydrates, as has been determined in previous bulletins of this Station. There has been a little heavier nutritive substance and

narrower ratio shown where the wheat bran was fed and less nutritive substance in combination with wider ratios where rice bran was fed. This has been followed by an excess in yield of milk and fat in favor of the rice bran rations as may be seen below in Table I. This excess is small, and in some cases has been diminished by differences in per cent of fat which is doubtless due to some circumstances of environment during the days on which tests were made or to some

TABLE I.—*Rations Consumed by Cows and Yields of Milk and Fat. Time: October 4 to November 12, 1897.*

COW NO. 7.

No. of Periods.	Name of Article.	Pounds fed daily.	Organic substance.	Digestible nutrients: Protein.	Carbohydrates	Fat.	Nutritive substance.	Ratio.	Pounds of milk yield per day being tested.	Per cent of fat found.	Pounds of butter fat found per day.
1st and 4th	Corn silage	28.	7.521	.202	3.718	.112					
	Rice bran, Corn bran Cotton-seed meal.	10.	8.566	1.592	3.854	.761					
			16.087	1.794	7. 72	.873	10.239	5.4	15.30	3.83	.386
2d and 3rd	Corn silage	29.75	7.991	.212	3.951	.119					
	Wheat bran, Corn bran, Cotton seed meal.	10.	8.480	1.708	3.755	.539					
			16.471	1.920	7.706	.658	10.284	4.9	14.99	3.96	.594

COW SPOT.

No. of Periods.	Name of Article.	Pounds fed daily.	Organic substance.	Protein.	Carbohydrates	Fat.	Nutritive substance.	Ratio.	Pounds of milk yield per day being tested.	Per cent of fat found.	Pounds of butter fat found per day.
1st and 4th	Corn silage	28.5	7.986	0.207	3.785	.114					
	Rice bran, Corn bran, Cotton seed meal.	10.	9.058	1.592	3.854	.761					
			17.024	1.799	7.639	.875	10.313	5.5	19.17	4.52	.865
2d and 3rd	Corn silage	30.6	8.574	.222	4.064	.122					
	Wheat bran, Corn bran, Cotton seed meal.	10.	8.968	1.708	3.755	.539					
			17.542	1.930	7.819	.661	10.41	4.9	19.01	4.22	.804

HEIFER, JERSEY KING 2ND'S NO. 5.

No. of Periods.	Name of Article.	Pounds fed daily.	Organic substance.	Protein.	Carbohydrates	Fat.	Nutritive substance.	Ratio.	Pounds of milk yield per day being tested.	Per cent of fat found.	Pounds of butter fat found per day.
1st and 4th	Corn silage	21.4	5.748	.154	2.842	.086					
	Rice bran, Corn bran, Cotton-seed meal.	6.	5.140	.955	2.312	.457					
			10.888	1.109	5.154	.543	6.806	5.9	4.69	5.55	.260
2d and 3rd	Corn silage	26.5	7.118	.192	3.519	.106					
	Wheat bran, Corn bran, Cotton-seed meal.	6.	5.088	1.025	2.253	.323					
			12.206	1.217	5.772	.429	7.418	5.7	4.43	5.63	.250

variation in testing. These tests were, however, probably correct, and the differences due to some of the conditions of environment which dominate changes from day to day in the rate of yield by every cow that is at all sensitive to differences of weather, treatment by attendant or her fellows, etc.

The weight of this trial is all toward the greater value of rice bran as compared with wheat bran for feeding milch cows in these combinations. This has no connection with price. The price of rice bran is usually three or four dollars per ton lower than wheat bran. Therefore the advantage of using the former where it can be obtained is much greater than the showing of this table would indicate.

III. WHEAT BRAN ALONE vs. RICE BRAN ALONE.

BY F. E. EMERY, M. S., AGRICULTURIST.

COW SPOT AND NO. 7.

Wheat bran was fed for one period, following period 4, then rice bran one period of nine days*, and wheat bran repeated. The rations and results in milk and fat are shown in Table II. The daily yield given in this table is not the average for the whole period, but the average for the four last days on which the composite samples were taken for the determination of fat. The results from Spot seem here to be against the rice bran. The feed had been so reduced from that allowed in period 4 that the yield of milk had dropped to 13.7 lbs. per day in period 5 from 18.79 lbs. at the end of period 4. But the rice bran ration proved to be deficient, undoubtedly in protein, for there was considerable more of fat and carbohydrate in this ration than was fed in the ration of wheat bran and the yield dropped still further when the change was made to rice bran, but when wheat bran was fed again for ten days there was an improvement or gain of .4 pounds of milk per day.

From No. 7 may be noted a loss of over two quarts of milk per day (4.54 pounds) from end of period 4 to end of period 5, the first one when wheat bran was fed alone with corn silage. There was a gain of one-fourth pound per day to end of rice bran period and a further drop to nearly one-fourth pound below the end of first period on wheat bran when the end of the second was reached. Had there been rice bran enough to have fed a second period different results might have been shown, but this cow only ate 7.4 pounds against 10 pounds of wheat bran, but she offset this with an increased consumption of silage. This in itself may have been the cause of the gain in produc-

*Rice bran gave out before the end of the ten days period.

tion of milk and of fat. No conclusion can be drawn here except as the cows lost weight as well as milk while fed on rice bran that it is insufficient, with silage as a source of the coarse food, to make a properly balanced ration for a milch cow.

TABLE II.—*Rations Consumed by Cows and Yields of Milk and Fat. Time: November* 13 *to December* 11, 1897.

COW SPOT.

No. of Period.	Name of Feeds.	Pounds fed daily	Organic substance. Lbs.	DIGESTIBLE NUTRIENTS Protein. Lbs.	Carbohydrate. Lbs.	Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Pounds of milk yield on test period of 4 days.	Per cent of fat.	Yield of fat per day. Lbs.
5th & 7th	Wheat bran	10.	8.197	1.197	3.634	.282					
	Corn silage	24.9	6.688	.179	3.307	.100					
			14.885	1.376	6.991	.382	8.749	5.8	12.61	3.92	.499
6th	Rice bran	10.	8.955	.849	3.982	.950					
	Corn silage	33.25	8.931	.239	4.416	.140					
			17.886	1.088	8.398	1.090	10.087	8.0	11.12	4.00	.445

COW NO 7.

No. of Period.	Name of Feeds.	Pounds fed daily	Organic substance. Lbs.	Protein. Lbs.	Carbohydrate. Lbs.	Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Pounds of milk yield on test period of 4 days.	Per cent of fat.	Yield of fat per day. Lbs.
5th & 7th	Wheat bran	10.	8.197	1.197	3.684	.282					
	Corn silage	26.75	7.185	.193	3.552	.109					
			15.382	1.390	7.236	.397	9.017	5.9	9.33	3.72	.348
6th	Rice bran	7.4	6.627	.628	2.947	.703					
	Corn silage	34.8	9.347	.251	4.621	.139					
			15.974	.879	7.568	.842	9.289	11.0	9.71	4.40	.427

The loss of milk from dropping the more nitrogenous by fodder, cotton-seed meal has been severe in each case and should not be followed in practice without replacing it with some other similar food or a portion of the silage with a leguminous fodder.

III. WHEAT BRAN vs RICE BRAN IN COMBINATION WITH COTTON-SEED MEAL.

BY F. E. EMERY, M. S., AGRICULTURIST.

HEIFERS MAY AND SUE.

These heifers were not weighed at the beginning of the first period but were weighed often during the experiment and from averages made of three fasting weights at the last end of each period they

gained quite steadily during the last 30 days and probably did so for the first ten days of this trial.

The summary shows an advantage for wheat bran over rice bran of over one quart of milk per day when cows were yielding between four and six quarts per day. The yield of fat calculated from composite tests shows a slight balance on the side of rice bran, but this is well within the limit of error to which the yield of milk is not subject. There is a difference of 11¼ per cent in flow of milk. This is lost when rice bran replaces wheat bran when the same amounts are fed with half the weight of bran in cotton-seed meal and good corn silage is fed freely enough to give the heifers all they would eat.

TABLE III.—*Rations Consumed by Cows with Yields of Milk and Fat Time: November and December,* 1897. *Rice Bran vs Wheat Bran.*

COW SUE.

No. of Period.	Name of Feeds	Pounds fed daily.	Organic substance. Lbs	Digestible Nutrients: Protein Lbs	Digestible Nutrients: Carbohydrate. Lbs.	Digestible Nutrients: Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs	Ratio.	Pounds of milk yield per day last 4 days period.	Per cent fat found.	Pounds butter fat per day.
1st & 4th	Corn silage	32.¼	8.662	0.232	4.283	.129					
Nov. 1-10	Wheat bran 4 } Cotton seed 2 } meal.	6	4.991	1.160	1.904	.296					
Dec. 1-10			13.653	1.392	6.187	.425	8.004	5.2	11.45	3.68	.420
2d & 4th	Corn silage	32.7	8.823	.235	4.343	.131					
Nov. 11-30	Rice bran 2 } Cotton-seed 1 } meal.	6	4.927	1.054	2.687	.493					
			13.760	1.289	7.030	.627	8.946	6.7	10.30	4.22	.435

COW MAY.

No. of Period.	Name of Feeds	Pounds fed daily.	Organic substance. Lbs	Protein Lbs	Carbohydrate. Lbs.	Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs	Ratio.	Pounds of milk yield per day last 4 days period.	Per cent fat found.	Pounds butter fat per day.
Nov. 1-10	Corn silage	32.½	8.729	.231	4.516	.130					
Dec. 1-10	Wheat bran 2 } Cotton-seed 1 } meal.	6	4.991	1.160	1.904	.296					
			13.720	1.394	6.220	.426	8.069	5.2	10.40	3 65	.380
Nov. 11-30	Corn silage	33.	8.861	.238	4.382	.132					
	Rice bran 2 } Cotton-seed 1 } meal.	6	4.927	1.054	2.887	.496					
			13.781	1.292	7.069	.628	8.989	6.7	9.09	4.55	.414

Even this rate is not so great as the usual difference in price, so under some circumstances it might be permissible to feed rice bran.

IV. HALF WHEAT MIDDLINGS vs. WHEAT BRAN ALONE.

By F. E. Emery, M. S., Agriculturist.

COWS: SPOT, AND NO. 7.

From cow No. 7 there was such a rapid falling off in yield of milk that the results of the feed were obscured. On the face of the compiled rations and yields of milk and fat there seems to be a balance in favor of wheat middlings, but there was hardly anything more than a trace of arresting the rapid decrease during the second period during which wheat middlings were fed. When bran again became the feed the decline in yield was sharply accentuated. See Table IV.

Spot yielded a little more milk, but the test showed less fat during the first bran period (7) than the previous period on rice bran yielded. But when Spot's food became a mixture of wheat middlings with an equal weight of bran there was a material gain in yield of both milk and fat. This is plainly shown by the figures in Table IV.

Table IV.—*Rations Consumed by Cows and Yields of Milk and Fat. Time: December* 2, 1897, *January* 11, 1898.

COW NO. 7.

No. of Period.	Name of Feeds.	Pounds fed daily.	Organic substance. Lbs.	Digestible nutrients: Protein, Lbs.	Digestible nutrients: Carbo-hydrate. Lbs.	Digestible nutrients: Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Pounds of milk yield per day being tested 4 days.	Per cent of fat.	Pounds of fat per day found.
7th & 10th	Corn silage	27.9	7.387	.198	3.652	.110					
	Wheat bran	10.	8.197	1.197	3.648	.282					
			15.584	1.395	7.300	.392	9.087	5.9	*7.58	4.25	.31
8th & 9th	Corn silage	29.7	7.977	.214	3.944	.119					
	Wheat bran 5, Wheat middlings 5		8.134	1.238	4.500	.311					
			16.111	1.452	8.444	.430	10.326	6.6	8.20	**4.20	.344

**Great fluctuations in per cent of fat indicate some constitutional disturbance. These averages are deceiving. See Table III.

COW SPOT.

No. of Period.	Name of Feeds.	Pounds fed daily.	Organic substance. Lbs.	Digestible nutrients: Protein, Lbs.	Digestible nutrients: Carbo-hydrate. Lbs.	Digestible nutrients: Fat (Ether Extract.) Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Pounds of milk yield per day being tested 4 days.	Per cent of fat.	Pounds of fat per day found.
7th & 10th	Corn silage	26⅛	7.017	.188	3.469	.105					
	Wheat bran	9¾	8.538	1.167	3.602	.275					
			15.555	1.355	7.071	.380	8.806	5.9	10.78	3.98	.426
8th & 9th	Corn silage	28.2	7.574	.203	3.745	.113					
	Wheat middlings, Wheat bran	10.	8.134	1.238	4.495	.311					
			15.708	1.441	8.24	.424	10.110	6.5	13.20	4.22	.558

*See Table III where rapid diminution of flow of milk in last period made the combined results show less favorable for bran than seems natural. Some effect foreign to this difference of feed must have been acting on this cow.

This experiment points to a decided gain in yields by the use of wheat middlings in the ration when fed at the rate of 50 per cent. The cost is somewhat more than that of bran, and the feeder must take that into consideration.

The tabular matter in Tables III and IV give very condensed summaries of these experiments.

V. ADDITION OF MILLET HAY TO RATION OF CORN SILAGE WHEAT BRAN 2 AND PEA MEAL 1 (COW PEA).

By F. E. Emery, M. S., Agriculturist.

The effect of this addition was scarcely perceptible in milk and butter fat on the whole. There was a small gain in weight much more marked in the Angus heifer than the others from the addition of the hay. The ration is shown to have been increased mainly in carbohydrates and the ratio consequently widened, but the effect was too small to realize anything for the hay from the milk.

Following the above was a second period of the same ration of wheat bran and cow-pea meal in the same proportions, 2 to 1, by weight, with corn silage limited only by the appetite of each cow. The meal was fed as nearly as possible in proportions of one pound of meal for each 100 pounds of live weight. Next was a period of change from corn-pea meal to cotton-seed meal. This was in same weight and proportions and was accompanied by a general advance in yield of milk and fat. Then green crimson clover was added to the last ration with no very marked result. The consumption of

Table V.—*Addition of Millet Hay to Ration of Corn Silage, Wheat Bran, Pea-meal, (Cow-pea). Time: February* 12 *to March* 24, 1898. *Heifers: Angus No.* 7 *and J. K. 2nd's, Daisy E., Miss Native and Polly K. 3rd.*

HEIFER MISS NATIVE.

1898.	Name of Article.	Pounds fed daily.	Organic substance. Lbs.	Nutritive substance.			Nutritive substance. Lbs.	Ratio 1:—	Daily yield of milk last days of period.	Per cent of fat.	Daily yield of fat last days.
				Protein. Lbs.	Carbo hydrates Lbs.	Fat Lbs.					
Feb 12–21 } Mar 15–24 }	Corn silage	21.15	5.694	.153	2.815	.085					
	Wheat bran 2 } Cowpea meal 1 }	7.	5.738	.985	2.979	.159					
			11.432	1.138	5.794	.244	7.176	5.6	10.34	4.30	.444
Feb 23 to Mar 14.	Corn silage	26.¾	7.185	.193	3.552	.107					
	Wheat bran 2 } Cowpea meal 1 }	6.8	5.574	.957	2.894	.154					
	Millet hay	3.17	2.514	.113	1.139	.002					
			15.273	1.363	7.585	.263	9.211	6.0	10.58	4.22	.446

TABLE V.—*Continued.*

HEIFER, ANGUS' NO. 7.

1898.	Name of Article.	Pounds fed daily.	Organic substance. Lbs.	Nutritive substance. Protein. Lbs.	Nutritive substance. Carbo-hydrates Lbs.	Nutritive substance. Fat. Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Daily yield of milk last days of period.	Per cent of fat.	Daily yield of fat last days.
Feb 12–21..	Corn silage	29.9	8.031	.215	3.971	.120					
Mar 15–24..	Wheat bran 2, Cowpea meal 1	8.	6.558	1.126	3.405	.182					
			14.589	1.341	7.376	.302	9.019	6.1	11.67	3.93	.452
Feb 23 to.. Mar 14.	Corn silage	32.5/8	8.763	.235	4.370	.131					
	Wheat bran 2, Cowpea meal 1	8.	6.558	1.126	3.405	.182					
	Millet hay	2.3	1.916	.143	.968	.021					
			17.237	1.504	8.743	.334	10.581	6.4	11.99	4.53	.512

HEIFER, JERSEY KING 2ND'S, DAISY E.

1898.	Name of Article.	Pounds fed daily.	Organic substance. Lbs.	Nutritive substance. Protein. Lbs.	Nutritive substance. Carbo-hydrates Lbs.	Nutritive substance. Fat. Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Daily yield of milk last days of period.	Per cent of fat.	Daily yield of fat last days.
Feb 12–21..	Corn silage	30.	8.058	.210	3.98	.120					
Mar 15-24.	Wheat bran 2, Cowpea meal 1	7.	5.738	.985	2.979	.159					
			13.796	1.196	6.959	.279	8.424	6.4	10.48	4.78	.501
Feb 23 to.. Mar 14.	Corn silage	32.1 5	8.649	.232	4.276	.129					
	Wheat bran 2, Cowpea meal 1	7.	5.738	.985	2.979	.159					
	Millet Hay	2.5/8	1.833	.137	.926	.120					
			16.220	1.354	8.281	.408	10.043	6.9	9.97	4.95	.493

POLLY K. 3RD.

1898.	Name of Article.	Pounds fed daily.	Organic substance. Lbs.	Nutritive substance. Protein. Lbs.	Nutritive substance. Carbo-hydrates Lbs.	Nutritive substance. Fat. Lbs.	Nutritive substance. Lbs.	Ratio 1:—	Daily yield of milk last days of period.	Per cent of fat.	Daily yield of fat last days.
Feb 12–21.. and Mar 4–15–24.	Corn silage	21.2	5.694	.153	2.815	.085					
	Wheat bran 2, Cowpea meal 1	7.	5.738	.985	2.979	.159					
			11.432	1.138	5.794	.244	7.176	5.6	13.00	4.58	.595
Feb 23 Mar 3–4–14.	Corn silage	21.8	5.855	.157	2.895	.087					
	Wheat bran 2, Cowpea meal 1	7.	5.738	.985	2.979	.159					
	Millet hay	2.3	1.916	.143	.968	.021					
			13.509	1.285	6.842	.267	8.394	5.8	13.91	4.98	.693
Mar 25 to April 3.	Corn silage	21.1/2	6.775	0.155	2.855	.086					
	Wheat bran 2, Pea meal 1	7.	5.738	.985	2.979	.159					
			12.513	1.140	5.834	.245	7.219	5.7	12.18	4.65	.566
April 4-13.	Corn silage	23.3	6.258	0.168	3.094	.093					
	Wheat bran 2, Cotton-seed meal 1	7.	5.738	.985	2.979	.159					
			11.996	1.153	6.073	.252	7.478	5.8	12.46	5.50	.685
	Corn silage	21.5	6.775	0.155	2.855	.086					
	Wheat bran 2, Cotton-seed meal 1	7.	5.738	.985	2.979	.159					
	Green clover (crimson).	11.1	1.931	.266	1.010	.056					
			14.444	1.406	6.844	.301	8.551	5.4	12.45	5.20	.647

silage was reduced by this change and the clover seemed only to have replaced some silage.

Rations for these later periods have been calculated for only one heifer, Polly K 3rd, a pure bred registered Jersey, raised on Experiment Farm. Other rations are similar and follow nearly the same rule: Approximately four-fifths of the standard for weight, when calculated up to 1000 pounds.

VI. WHEAT BRAN AND COTTON-SEED MEAL vs. RICE BRAN AND COTTON-SEED MEAL.

BY J. M. JOHNSON, M. S., ASSISTANT AGRICULTURIST.

To compare the food value of a mixture of wheat bran two parts and cotton-seed meal one part by weight with a mixture of rice bran two parts and cotton-seed meal one part; also to compare the value of wheat bran two parts and cotton-seed meal one part with wheat middlings two parts and cotton-seed meal one part; also to compare the feeding value of a grain mixture of wheat bran two parts and cotton-seed meal one part with a grain allowance of wheat bran alone, the following experiments were made:

While the wheat bran cotton-seed meal mixture was being compared with the rice bran cotton-seed meal mixture, and the wheat bran cotton-seed meal mixture with the wheat middling cotton-seed meal mixture, the cows in the trials were limited to a grain allowance of ten pounds per head per day. But when the wheat bran cotton-seed meal mixture was being compared with wheat bran alone the cows received all the grain they would eat up clean, occasionally some remained in the mangers after the cows had finished feeding, this was weighed back and deducted from the amount charged to the cow by the feeder. During the entire time of the feeding experiments each cow under trial received a daily allowance of from forty to forty-five pounds of silage. When any of this remained after the cow was through eating it was weighed back and deducted from that originally charged to her. Thus the appetitite of the individual regulated the amount of food consumed.

The cow No. 1 is a grade Guernsey, showing a strong tendency toward meat production and but very little of the qualities which go to make up a good animal for the milk or butter dairy. Cow No. 2, is a registered Jersey, showing the milk and butter type quite well developed. No. 1 dropped a calf September 29th. No. 2 calved October 4th. They had therefore been milking forty and thirty-five days respectively at the beginning of these experiments.

The time of experimentation was divided into periods of ten days

each. When two foods or food mixtures were under study one was fed during the first period, the other during the next two, and the first mixture again during the fourth or last period. Thus the difference in milk flow and fat content due to advancing period of lactation was eliminated.

Cow No. 1 was used alone in making the comparison of the wheat bran cotton-seed meal mixture with that of rice bran cotton-seed meal. While cow No. 2 was used in the comparison of wheat bran cotton-seed meal mixture with wheat middling cotton-seed meal. This prevents any comparison, from these trials, of wheat midlings with rice barn.

Cow No. 1 consumed, during the twenty days constituting periods I IV, 200 pounds of the wheat bran cotton-seed meal mixture with 784 pounds of silage containing 397.94 pounds dry matter, to produce 267.85 pounds of milk containing 15.764 pounds of butter fat. While during the twenty days constituting periods II and III she consumed 200 pounds of the rice bran cotton-seed meal mixture with 783½ pounds of silage containing 398.86 pounds dry matter to produce 266.70 pounds of milk containing 16,346 pounds of butter fat. This is set forth in a more condensed form in the following table:

TABLE VI.—*Showing the food consumed and the dry matter contained. Also the milk produced with the per cent of fat and total fat contained, and the amount of milk and fat yielded per one pound of dry matter in the food.*

Cow.	Period.	FOOD CONSUMED.			MILK AND BUTTER FAT PRODUCED.			One Pound of Dry Matter in the Food Produced.	
		Wheat Bran, Cotton-seed Meal. Lbs.	Silage. Lbs.	Dry Matter in Food. Lbs.	Milk. Lbs.	Per Cent Fat.	Fat Lbs.	Milk. Lbs.	Fat. Lbs.
No. 7	I & IV	200.	784.	397.94	267.85	5.89	15.776	.673	.0396
		Rice, Bran, Cotton-seed Meal.							
No. 7	II & III	200	783.5	398.86	266.70	6.13	16.358	.668	.0409

Practically equal amounts of dry matter were consumed in periods I and IV, combined or while wheat bran and cotton-seed meal formed the grain allowance) and during period II and III or while rice bran and cotton-seed meal was being fed.

One hundred pounds of dry matter in the wheat bran cotton-seed meal mixture produced .5 of a pound more milk and .13 of a pound less butter fat than did the same amount of dry matter in the rice bran cotton-seed meal mixture.

This experiment shows that under existing conditions there is no difference in the feeding value of rice bran and wheat bran.

Later trials with the entire college dairy herd go to substantiate the results of the foregoing experiment with cows which relish the rice bran, but to some animals it is distasteful, and they will only eat it when forced to by hunger, with such animals it is impossible to get good results with rice bran, and as all cows seem to relish the wheat bran we give it the preference and recommend its use rather than rice bran at the same price per ton.

VII. WHEAT BRAN AND COTTON-SEED MEAL vs. WHEAT MIDDLINGS AND COTTON-SEED MEAL.

BY J. M. JOHNSON, M. S., ASSISTANT AGRICULTURIST.

Cow No. 2, consumed 200 pounds of a mixture of wheat bran and cotton-seed meal with 780 pounds of silage containing 396.82 pounds dry matter during the twenty days of periods I and IV combined; to produce 342.65 pounds of milk containing 19.802 pounds of butter fat. During the twenty days of periods II and III she consumed 200 pounds of the mixture of wheat middlings and cotton-seed meal and 784 pounds of silage, containing 398.39 pounds of dry matter, to produce 356.10 pounds of milk containing 19,229 pounds of butter fat. The following table shows the result of this experiment in a more condensed form:

TABLE VII.—*Showing the food consumed and the dry matter contained. Also the milk produced and the per cent of fat and total fat it contained, and the amount of milk and fat given per one pound of dry matter in the food.*

Cow.	Period.	FOOD CONSUMED.			MILK AND BUTTER FAT PRODUED			One Pound of Dry Matter in Food Produced.	
		WheatBran, Cotton seed Meal. Lbs.	Silage. Lbs.	Dry Matter in Food. Lbs.	Milk. Lbs.	Per Cent. Fat.	Fat, Lbs.	Milk. Lbs.	Fat. Lbs.
No. 2	I & IV	200	780	396.82	342.65	5.78	19.805	.863	.049
		Wheat Middlings and Cotton-seed Meal.							
No. 2	II & III	200	784	398.39	356.10	5.40	19.229	.8938	.0482

This trial resulted in 200 pounds of the wheat middlings cotton-seed meal mixture plus 784 pounds of silage, producing 13.45 pounds

more milk and .576 pounds less fat than 200 pounds of the wheat bran cotton-seed meal mixture, plus 780 pounds of silage. This is a difference of 3.92 per cent in milk yield in favor of the grain mixture containing wheat middlings; and of 2.90 per cent in butter fat in favor of the mixture containing the wheat bran. For each 100 pounds of dry matter consumed in the ration of wheat bran cotton-seed meal and silage there was a return of 86.3 pounds of milk or 4.99 pounds of fat, while for 100 pounds of the dry matter consumed in the wheat-middling cotton-seed meal and silage ration there was 89.38 pounds of milk or 4.82 pounds of fat produced.

The result of this trial indicates that there is practically no great difference in the food value of wheat bran and wheat middlings when fed with one half their weight of cotton-seed meal.

VIII. WHEAT BRAN AND COTTON-SEED MEAL vs. WHEAT BRAN ALONE.

By J. M Johnson, M S., Assistant Agriculturist.

In this experiment, which began December 30th and ended February 8th, the two cows, (No. 1 and No. 2) were used. They received the wheat bran cotton-seed meal mixture during periods I and IV, and for periods II and III they received a grain allowance of wheat bran alone. Throughout the entire trial they received as much grain and silage each day as they would eat.

Table VIII.—*Showing the food consumed and the dry matter it contained. Also the milk produced and the per cent of fat and total fat it contained, and the amount of milk and fat given per pound of dry matter in the food.*

Cow.	Period.	Food Consumed.			Milk and Butter Fat Produced.			One Pound of Dry Matter in the Food Produced.	
		Wheat Bran and Cotton-seed Meal. Lbs.	Silage. Lbs.	Dry Matter consumed. Lbs.	Milk. Lbs.	Per Cent Fat.	Fat. Lbs.	Milk. Lbs.	Fat. Lbs.
No. 1	I & IV	226	751.5	412.01	215.10	5.85	12.582	5.22	.030
No. 2	I & IV	233	779.0	425.95	320.25	5.78	18.510	.752	.043
Total	I & IV	459	1530.5	837.96	535.35	5.81—	31.092	.639	.037
Aver'ge	I & IV	229.5	765.25	418.98	267.67	5.81—	15.546	.639	.037
		Wheat Bran alone.							
No. 1	II & III	196.25	637.50	350.48	170,15	5.89	10.022	.485	.028
No. 2	II & III	181.00	761.50	371.87	271.25	5.02	13.617	.729	.037
Total	II & III	377.25	1399.00	722.35	441.40	5.35+	23.639	.611	.0326
Aver'ge	II & III	188.62	699.50	361.17	220.70	5.35+	11.819	.611	.0326

The two animals consumed for periods I and IV 459 pounds of the wheat bran cotton-seed meal mixture, and 1530.5 pounds silage (containing 837.96 pounds dry matter), to produce 535.35 pounds of milk containing 31.092 pounds of butter fat. While for periods II and III they consumed 377.25 pounds of wheat bran and 1399.00 pounds of silage, containing 722.35 pounds dry matter, to produce 441.40 pounds of milk containing 23.639 pounds butter fat.

This trial resulted in one hundred pounds of the dry matter in the wheat bran cotton-seed meal mixture and silage producing 63.9 pounds of milk containing 3.7 pounds fat; while the same amount of dry matter in the wheat bran silage ration produced 61.1 pounds of milk containing 3.26 pounds fat. This is a difference of 4.75 per cent for milk production and 13.51 per cent for butter or fat production in favor of the wheat bran cotton-seed meal mixture over wheat bran alone.

IX. MILK RECORDS AT THE EXPERIMENT FARM.

By F. E. Emery, M. S., Agriculturist.

"When this record began in 1891, the Experiment Station had four cows in its stable, one a registered Jersey, one unregistered, and one grade, the fourth belonged to the Agricultural and Mechanical College. The registered cow was stripping and the unregistered one had been milking about three months, having come in milk prematurely by an injury which resulted in permanent lameness.*" This reference is also the one by which may be found the method of making the record. It is simple and easy. The wonder is any farmer will keep a cow and feed and care for her by the year without knowing whether it pays, when by simply keeping a record he would be sure, and where several cows are kept this would point out the profitable cows.

How much milk should a cow give in order to be classed as a profit maker? Evidently the amount depends on the cost of feed and value of milk. A number of years ago the New York State Dairy Commissioner estimated from a large mass of data which came to his office that the average yield from New York cows was not above 3000 pounds.

The United States census figures show that North Carolina cows produced 2136.5 pounds milk each in 1879 and New York cows 3987.6 pounds.** Later statistics gathered in New York show a gain for New York cows.

---

*Bulletin No. 116, p. 185. **Bulletin No. 101, p. 220.

The first year's record here showed that of seven cows kept and milked long enough to publish their records four yielded above three thousand and one of these above four thousand pounds of milk during that year, 1891.

In 1892 three thousand for a grade and four thousand for a pure but unregistered Jersey were the highest yields and neither of these was in the list above three thousand pounds in 1891. Late in this year a heifer began to yield milk which has developed into the deepest milker of the herd.

In 1893 there were eight cows yielding above three thousand pound., and only one of these to reach that limit in previous years was of the list and she barely in it. Of the other seven one yielded nearly and two above four thousand pounds, one 5213 pounds and another, No. 5, the second highest yielding cow, reached 6607 pounds. These yields and those of 1894 may be found in Bulletin No. 116.

In this year's record nine cows out of eleven yielded above 3300 pounds, and one of these other two was a heifer which was in milk only two months but yielded 1166 pounds in that time. Five records were close to 4000 pounds, one 4506, one 5186, and only one as high as 6175.2. The ten cows averaged 4102.5 pounds, and their butter yield averaged 246.7 pounds.

In 1895 the heifer Spot and cow No. 5 were the only ones of fourteen on record to approximate 4000 pounds of milk. The third highest was cow No. 7 with 3741 pounds of milk. These three at 85 per cent butter fat yielded 238.8, 319.6 and 203.4 pounds of butter; or, at World's Fair rate of 80 per cent fat, the yields were 253.7, 339.6 and 216.1 pounds, while the Jersey, Dora McKee, with a yield of 3204.4 pounds of milk, was credited with 238.9 or 254.2 pounds of butter.

It would seem from this that this herd was entitled to place an easy standard at 6000 pounds of milk and 300 pounds of butter per cow per year. If ten months are allowed as the proper length of lactation in every year then each cow to reach the standard must average 20 pounds of milk and one pound of butter daily for this time, 300 days. The yield should be nearly double hese amounts at their highest point and be held for longer or shorter time accordingly.

During the year 1897 the more valuable cows of this herd were condemned because of spread of tuberculosis which was also found in many of the heifers from these cows. The young herd from which records surpassing the performances of their dams was also broken up.

In 1897 and 1898 the following records were made:

The highest yields per day prvious to 1899 was 36.3 pounds, by Daisy E and 35.9 by Spot.

The highest yield per day has now been 39.45 pounds, by May, Shorthorn.

The highest yields per month have been by Daisy E, 1006 pounds, and May 1026.4 pounds.

The cow that yields two gallons of milk per day for ten months will exceed 5200 pounds, and she should yield nearly four gallons per day when fresh.

The highest yearly records were made in 1896.

	Yield of Milk. Pounds.	Yield of 85 Per Cent Butter.	Yield of 80 Per Cent Butter.
Spot	7464.	396.9	421.7
No. 5	6714.7	291.	309.2
Daisy E	6750.3	296.4	315.
No 2	5292.2	306.8	326.
Polly K	4652.2	297.3	315.9
No. 7	4478.7	234.	248.5
No. 20	4358.	248.4	263.9
Average	5672.6	295.8	333.4

Name of Cow.	Yield of Milk.
	Pounds.
Spot*	6516.7
No. 7*	3650.5
*After others were condemned, these went to pasture and had less than usual care.	
Shorthorn heifer, May	4804.5
Shorthorn heifer, Sue	4504.
1898	
Spot	5885.6
May	4396.4
Sue	4390.
Jersey King 2nd's No. 5	1643.6
Miss Ashe	3469.2
8 months of 1899.	
Spot	4122.5
May	4238.5
Sue	3042.8
Jersey King 2nd's No. 5	1531.6
Miss Ashe*	1870.

* Sold for beef before 7 months were expired.

INDEX TO PUBLICATIONS, 1898-'9.

(All References are to Pages.)